(Established 1832.)
AMERICAN ENGINEER AND RAILROAD JOURNAL.

MAY, 1906.

## STANDARDIZING LOCOMOTIVE EQUIPMENT.

CANADIAN PACIFIC RAILWAY.

II.

As was stated in the last number, the standard locomotive parts recently adopted by the Canadian Pacific Railway cover broadly but three types—the consolidation, ten-wheel and Pacific types as typified by classes M4, D10 and G1. Classes D11 and G2, which closely follow classes D10 and G1, were also included in the table, showing the broad field covered by the standards.

Of the consolidation locomotives included in the equipment of the road, class M4 contains 41 engines and is divided into four sub-classes, which differ from each other in boiler arrangement, due to the use of different types of superheaters and on account of some of the engines having driving tires fitted with retaining rings for hill service. Classes M4a and M4c include 21 engines fitted with the Schmidt fire tube type of superheater, having 88—1¼-in. superheating tubes 12 ft. 11½ ins. long, giving a surface of 375 sq. ft., and classes M4b and M4d have the Cole fire tube type of superheater, comprising 55—1¾-in. tubes 13 ft. 6 ins. long, giving a surface of 340 sq. ft. All of these were built during the latter part of 1904; the M4d (20 engines) at Schenectady and the others at Kingston and Montreal. They are all 180 per cent. engines.

The next older locomotives of the consolidation type are 42 of class M3, which are 155 per cent. engines. They are two-cylinder compounds of the Schenectady design, delivered in 1900. None of these are fitted with superheaters, but they were given considerable attention in the designing of the standards and a large percentage of the standard parts are used on them.

Class M4, which may be considered to be the standard consolidation locomotive, is a 21 by 28-in. simple engine, having 57-in. drivers and weighing 186,200 lbs., of which 163,700 lbs., or 87½ per cent., is on drivers. The tractive effort of 36,800 lbs. bears a ratio of 4.45 to the tractive weight. The boiler is of the extended wagon top type 69 ins. in diameter at the front ring and carries a pressure of 200 lbs. The number of tubes, and hence the tube heating surface, vary in the different sub-classes according to the type of superheater used. Of those engines using the Schmidt boiler tube type there are 22—5-in. tubes and 244—2-in. tubes, which gives a tube heating surface of 2,216 sq, ft., and with a firebox heating surface of 165 sq. ft., common to all sub-classes, gives a total heating surface of 2,281 sq. ft. In those engines using the Cole type of superheater there are 55—3-in. tubes and 255—2-in. tubes, giving a tube heating surface of 2,705 sq, ft. and a total heating surface of 2,870 sq. ft. The engines shown in the table of dimensions herewith are the ones using the Schmidt type, and hence the ones having the smaller heating surface but a somewhat larger superheating surface. The tubes in all cases are 14 ft. 1⅜ ins. long.

The firebox measures 65¼ by 96⅝ ins. at the mud ring, giving a grate area of 43 sq. ft. The grate slopes forward in two sections. The outside firebox sheet is vertical and the inner sheet, which is 4½ ins. from it at the mud ring, inclines inward, giving a water space of 6½ ins. at the point where the curve of the crown sheet begins. The mud ring is 5 ins. wide in front and 3½ ins. wide at the back. The water space at the back increases to 4¼ ins. at the crown sheet. The crown sheet is 3 ins. higher at the front end than at the back and is radial stayed. The front flue sheet is set into the forward barrel sheet a distance of about 14 ins., which gives a front end nearly 70 ins. long, the stack being set 30 ins. ahead of the flue sheet. This space is required for the installation of the superheaters.

An order of 20 of this class, which are now under construction, are to have the steam pressure reduced to 175 lbs. and the cylinders increased to 22½ by 28 ins., which will give the same power as 21 by 28-in. cylinders with 200 lbs. pressure. They are to be equipped with the C. P. R. superheater, the economy of which it is believed will offset the greater cylinder volume and the reduction in boiler troubles due to the lower pressure will be clear gain. This will be the first example in this country of obtaining a saving from the use of superheated steam through this channel.

The illustrations show the rational design of this boiler very clearly, and cross-sections are given showing the location of tubes when used with either design of superheater. Some of the special fittings which are of interest will be considered later.

The cylinders, frames, wheels and other standard parts of this locomotive will be illustrated and described in a later article.

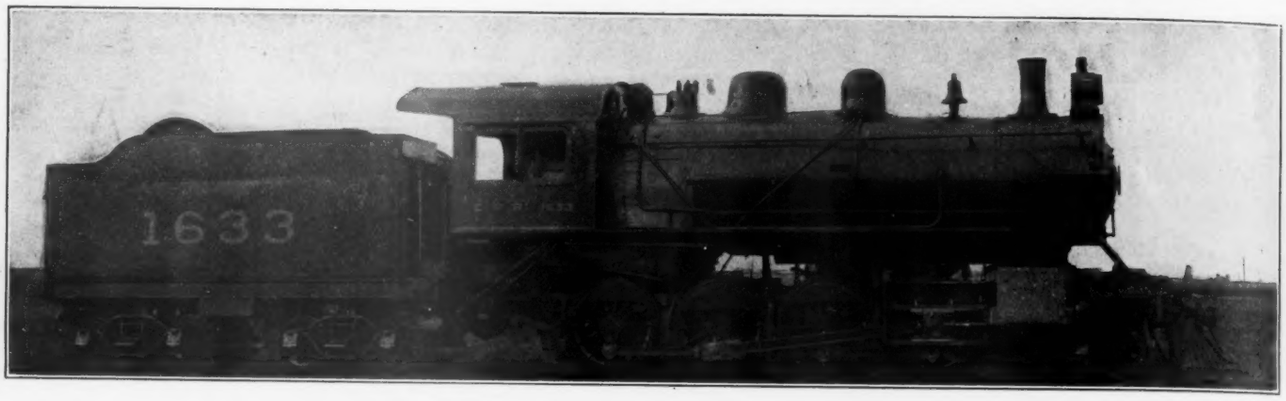
The 10-wheel standard type, class D10, includes 95 engines to which may be added 5 wide firebox culm burners, class D11, that are similar with the exception of the boiler, back frames, etc.

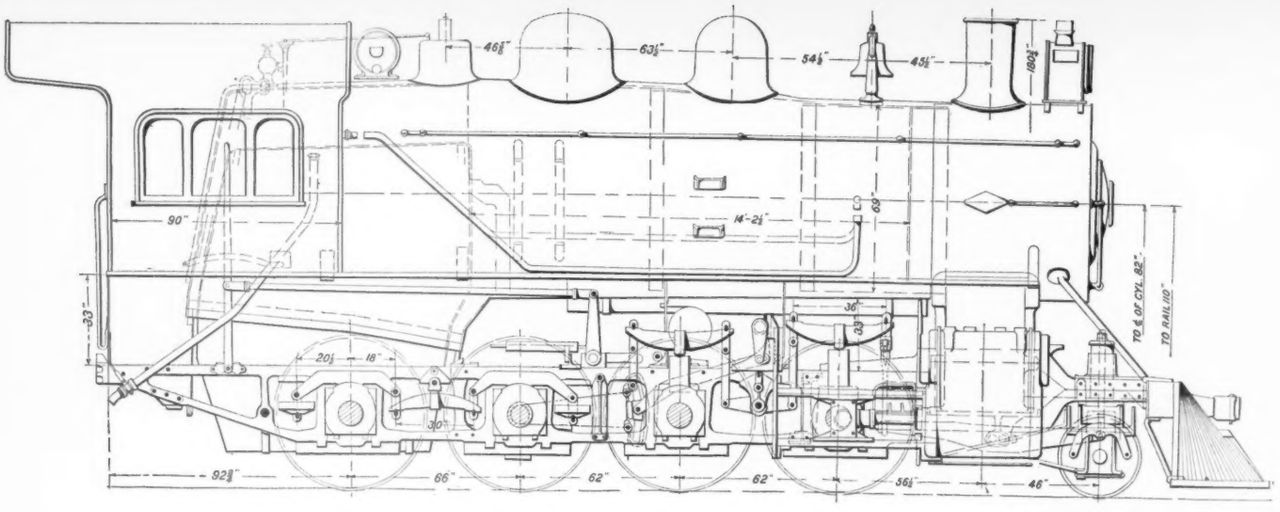
Class D9 contains 38 155 per cent. two-cylinder compound locomotives, which use more standard parts than any other single class not considered as a standard engine. Thirty-seven of this class are Schenectady compounds having cylinders 23 and 35 by 30 ins., 63-in. drivers and 200 lbs. boiler pressure. They weigh 190,000 lbs., with nearly 142,000 lbs. on drivers, and have 378—2-in. tubes, giving a heating surface of 2,885 sq. ft. and a total heating surface of 3,065 sq. ft. One of this class is equipped with the Schmidt fire tube type of superheater.

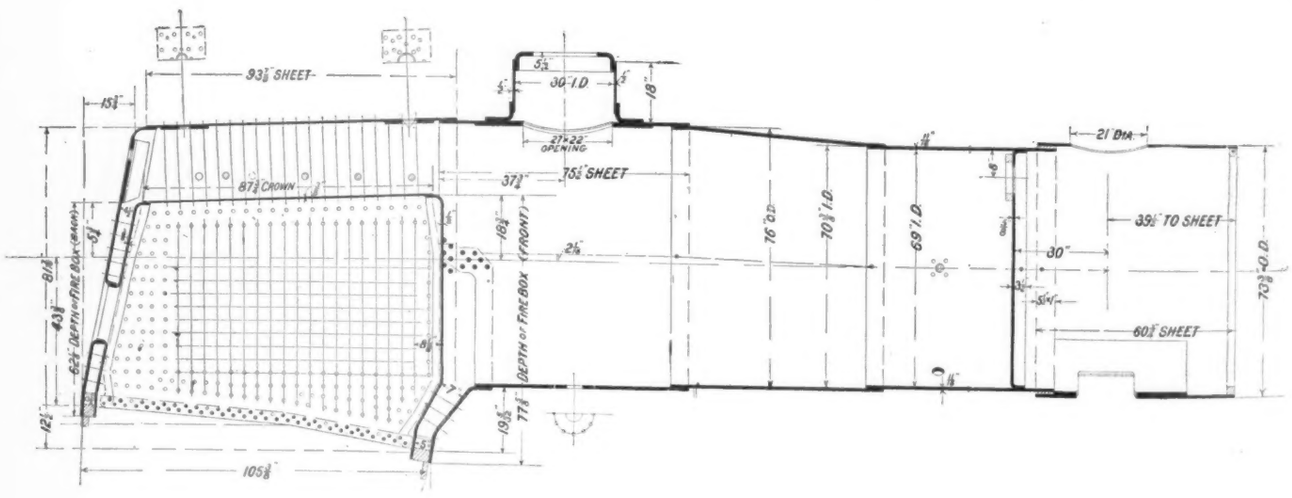
Classes D10 and D11 are 21 by 28-in. piston valve engines, with 63-in. drivers. Class D10 weighs 190,000 lbs. total, of which 141,000 lbs. is on drivers. It is divided into three subclasses, because of the different types of superheaters used. Ten of the engines have Schmidt superheaters with 88—1¼-in. superheating tubes having an average length of 13 ft. 1 in. and giving a superheating surface of 378 sq. ft.; 55 are equipped with the Cole superheater, also having 88—1¼-in. superheating tubes 12 ft. 8 ins. long, giving a heating surface of 370 sq. ft., and the remaining 30 engines have the C. P. R. superheater, having the same number of tubes and the same surface as the Cole. In all cases the tube heating surface in the boiler is 2,233 sq. ft. and that in the firebox 180 sq. ft., giving a total of 2,013 sq. ft. The grate area of 49 sq. ft. gives 49.2 sq. ft. of heating surface per square foot of grate.

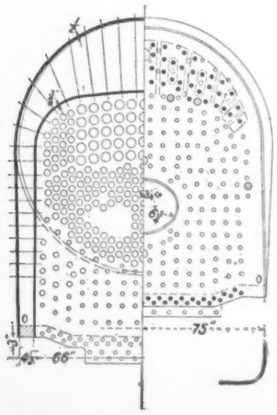
Class D11, the boiler for which is illustrated herewith, has somewhat shorter flues than the D10, being 13 ft. 7⅛ ins., as compared to 14 ft. 2⅞ ins., and has a much larger grate area. As can be seen, the firebox is very shallow and the grate is level. A single door opening of exceptional width has been used. In order to allow firing so wide a grate from a single door this opening was made 40½ ins. wide. This class is also equipped with a C. P. R. superheater, having 88—1¼-in. tubes with an average length of 10 ft. 8 ins., giving a superheating surface of 307 sq. ft. The shorter flues reduce the total heating surface as compared with D10 and give a total of 2,313 sq. ft., of which 188 is in the firebox and 2,125 in the tubes. The illustrations shows the general arrangement of this boiler, which differs from that used on the class D10 principally in the firebox. Some of the boiler details will be taken up later.

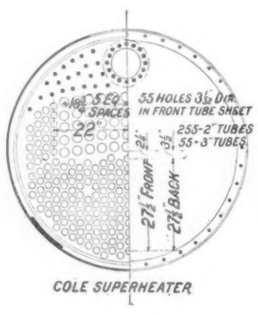
The general elevation of the class D10, illustrated herewith, shows the general dimensions and location of the different parts, and later on in this article the details will be taken up and separately discussed. The class D11 differs in general arrangement from D10 in the fact that the very wide firebox made it necessary to place the cab on the boiler shell. This changed the location of the sand box and bell, the former



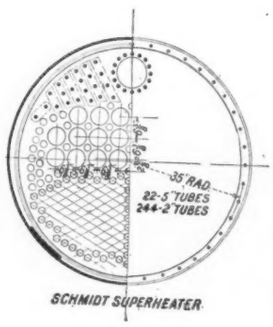




COLE SUPERHEATER

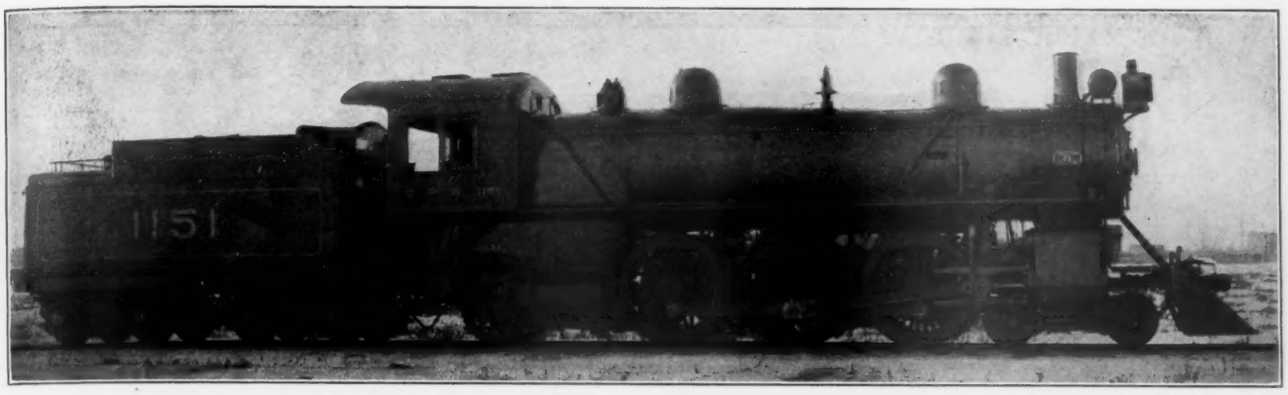


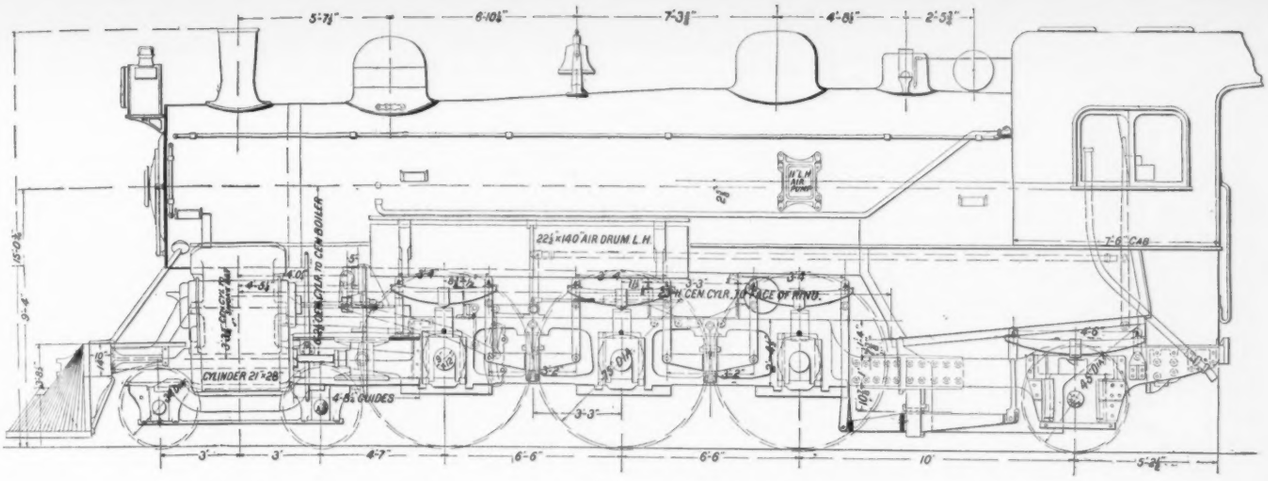

SCHMIDT SUPERHEATER

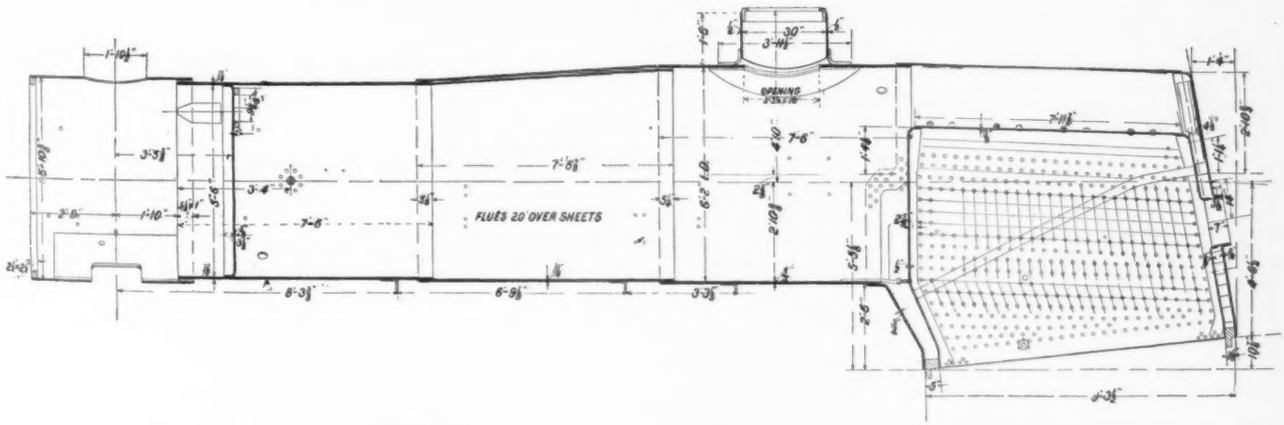
STANDARD CONSOLIDATION LOCOMOTIVE, CLASS M4.—CANADIAN PACIFIC RAILWAY.

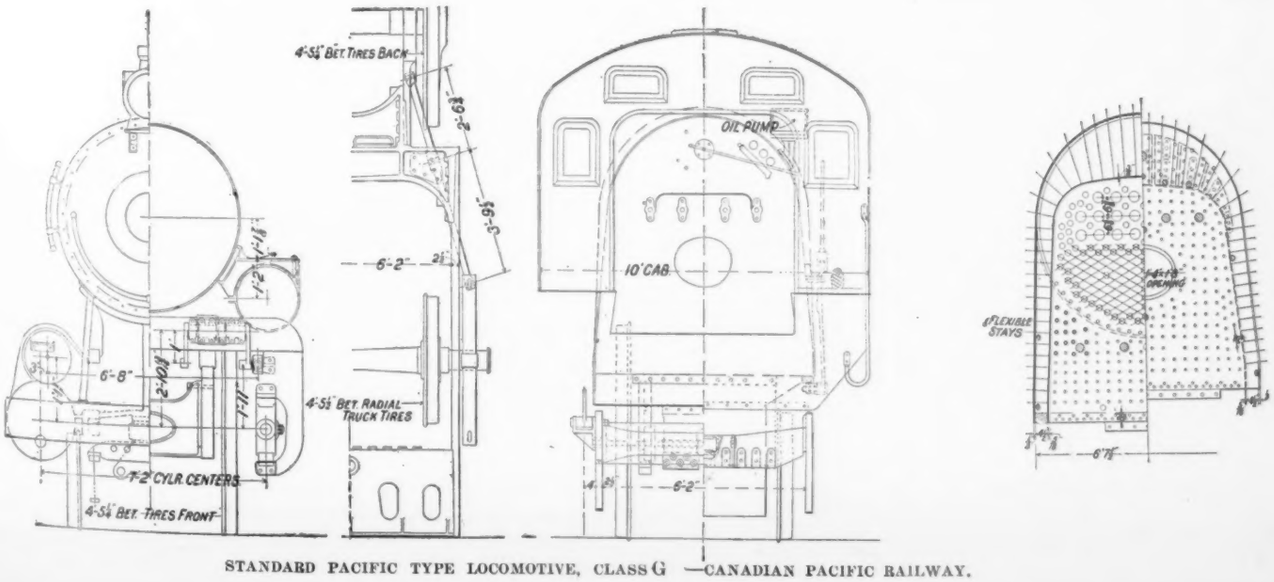
being placed on the front barrel sheet and the latter above the firebox. A fireman's cab, which is of standard design except for length, is placed at the rear of the firebox. This location of the cab made some rearrangement of the location of the air drums, air pump, etc., necessary.

The Pacific type locomotives on this road are all included in the classes G1 and G2, which differ from each other principally in the size of the driving-wheels, the former having 75-in. wheels and the latter 69-in., and in the length of tubes, the former being 19 ft. 6 ins. long and the latter 20 ft. long. These classes are the first to be designed complete,

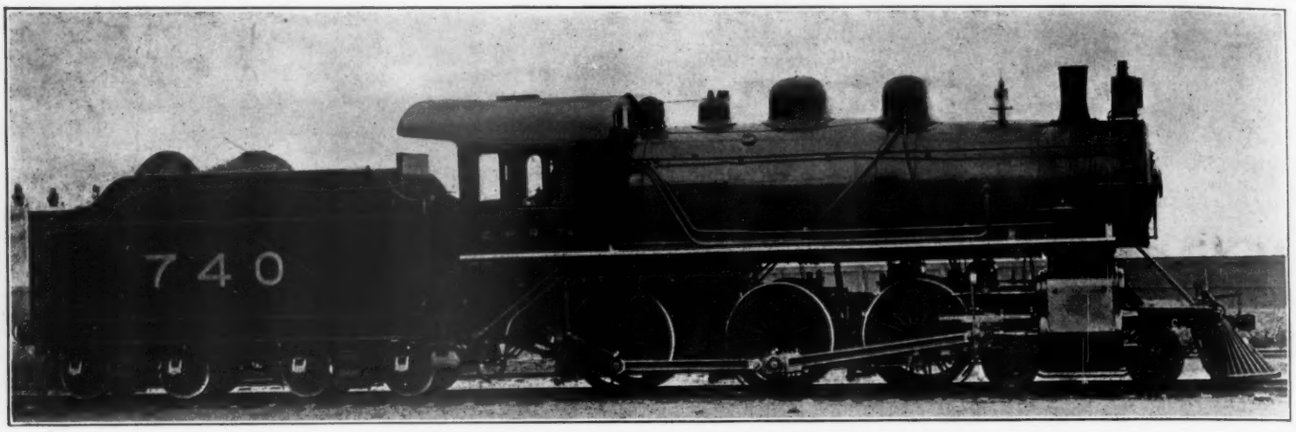


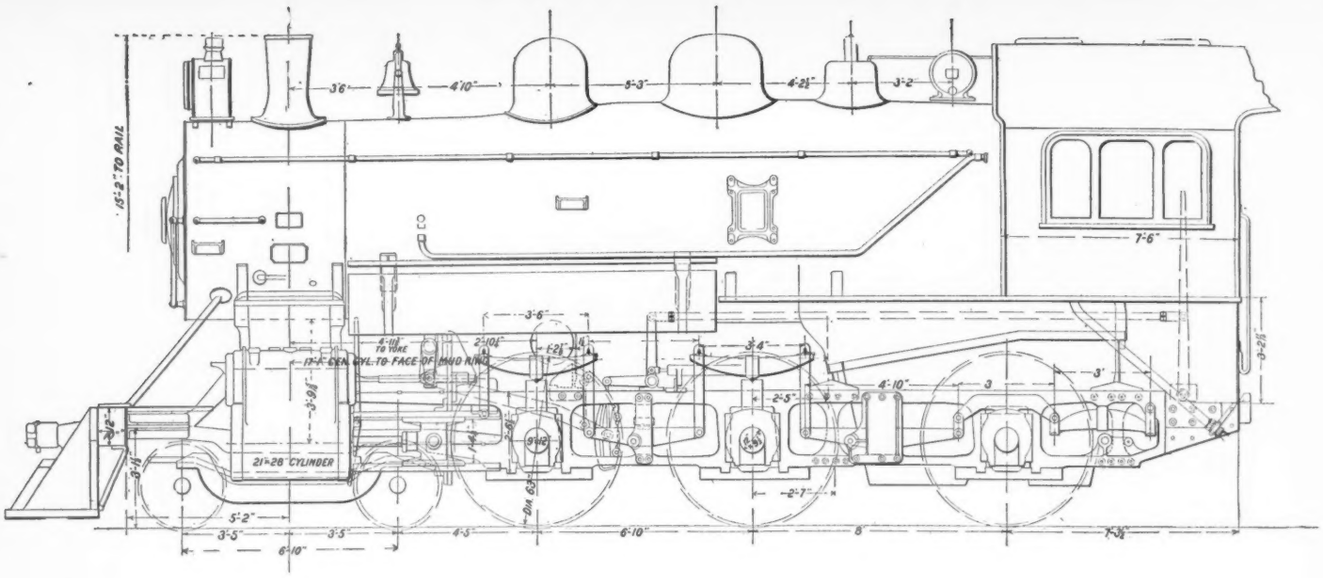



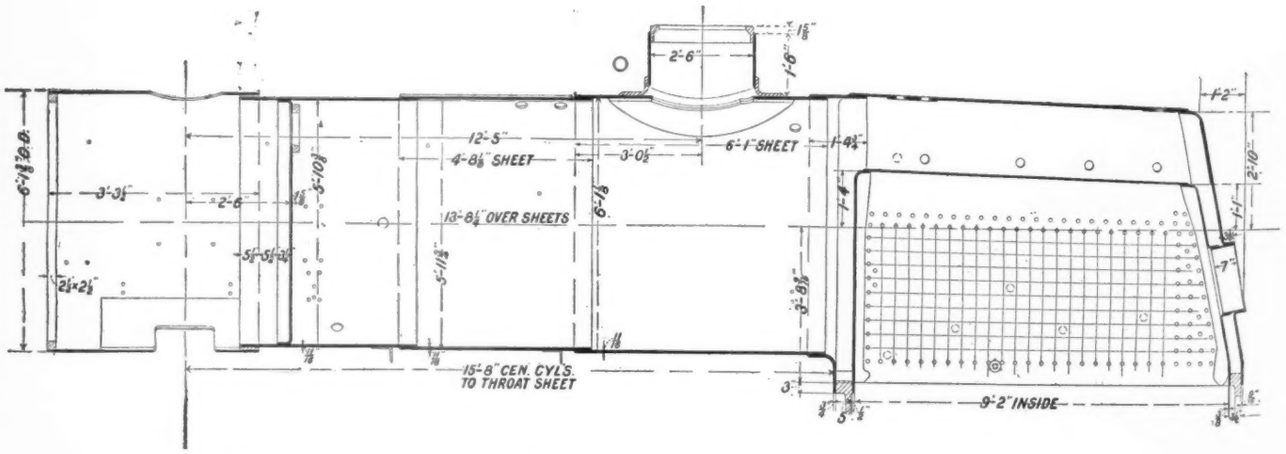



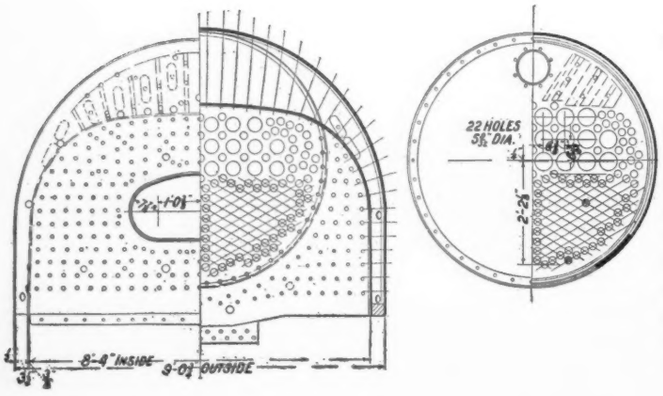




STANDARD PACIFIC TYPE LOCOMOTIVE, CLASS G —CANADIAN PACIFIC RAILWAY.




STANDARD TEN-WHEEL LOCOMOTIVE, CLASS D10; BOILER, CLASS D11.

—CANADIAN PACIFIC RAILWAY.

since the adoption of the standard parts, and, while, since their design was under consideration at the time the standards were being adopted, they bore some direct influence upon the adoption, they can in general be considered as an illustration of how the standard parts can be used in designing new power of an entirely different type. Reference to the table of parts shown in our April issue, will make clear the exceedingly broad application of the parts suitable for the consolidation and ten-wheel standard engines to this Pacific type. While, of

course, in such matters as frames and boilers it is necessary to use new designs, in most other respects, such as cylinders, engine trucks, driving boxes, frame fittings, etc., standard parts are applicable.

In the table herewith will be found the general dimensions of class G2. The class G1, as mentioned above, differs in size of drivers and length of flues, hence in heating surface. There is also a difference in the length of the grate, which for the class G1 is 70 by 93⅝ ins., giving a grate area of 45¼ sq. ft. The heating surface for this class is: tubes, 2,777 sq. ft.; firebox, 180 sq. ft.; total, 2,957 sq. ft. These engines weigh 214,300 lbs., of which 139,300 or 65 per cent. is on drivers. They have 21 by 28-in cylinders with piston valves, and give a tractive power of 30,400 lbs. As will be seen in the table the B. D. ratio (tractive effort x diameter of drivers ÷ by heating surface) is 670, being lower than for any of the other standard engines, as would be expected, when it is considered that these engines are to do their best work at high speed with a short cut-off. From an examination of the ratios it would seem that they have sufficient boiler power to be capable of handling as heavy a train as the tractive power will permit under adverse conditions. The boiler for the class G2 is illustrated herewith and it can be seen that the shell is very long, comprising three sheets, the centre one being the connecting sheet, and that the front flue sheet is set back into the barrel about 20 ins., being 41⅝ ins. from the centre of the stack. The front barrel is 66 ins. inside diameter and the dome sheet is 74 ins. The width of the mud ring differs from the standard one in front where it is 5 ins. instead of 5½. It will be seen that the grate is on a slight slope forward, and that its front end is further below the bottom row of flues than is usual in this type of engine. The arch tubes shown in this illustration were not used.

The engines in both of these classes are equipped with C. P. R. superheaters of the latest design, giving a superheating surface of 630 sq. ft. The large tubes for the superheater pipes are 5 ins. in diameter and 22 ins. in number. The other fire tubes, of which there are 209, are 2¼ ins. in diameter and are set at 3-in. centres.

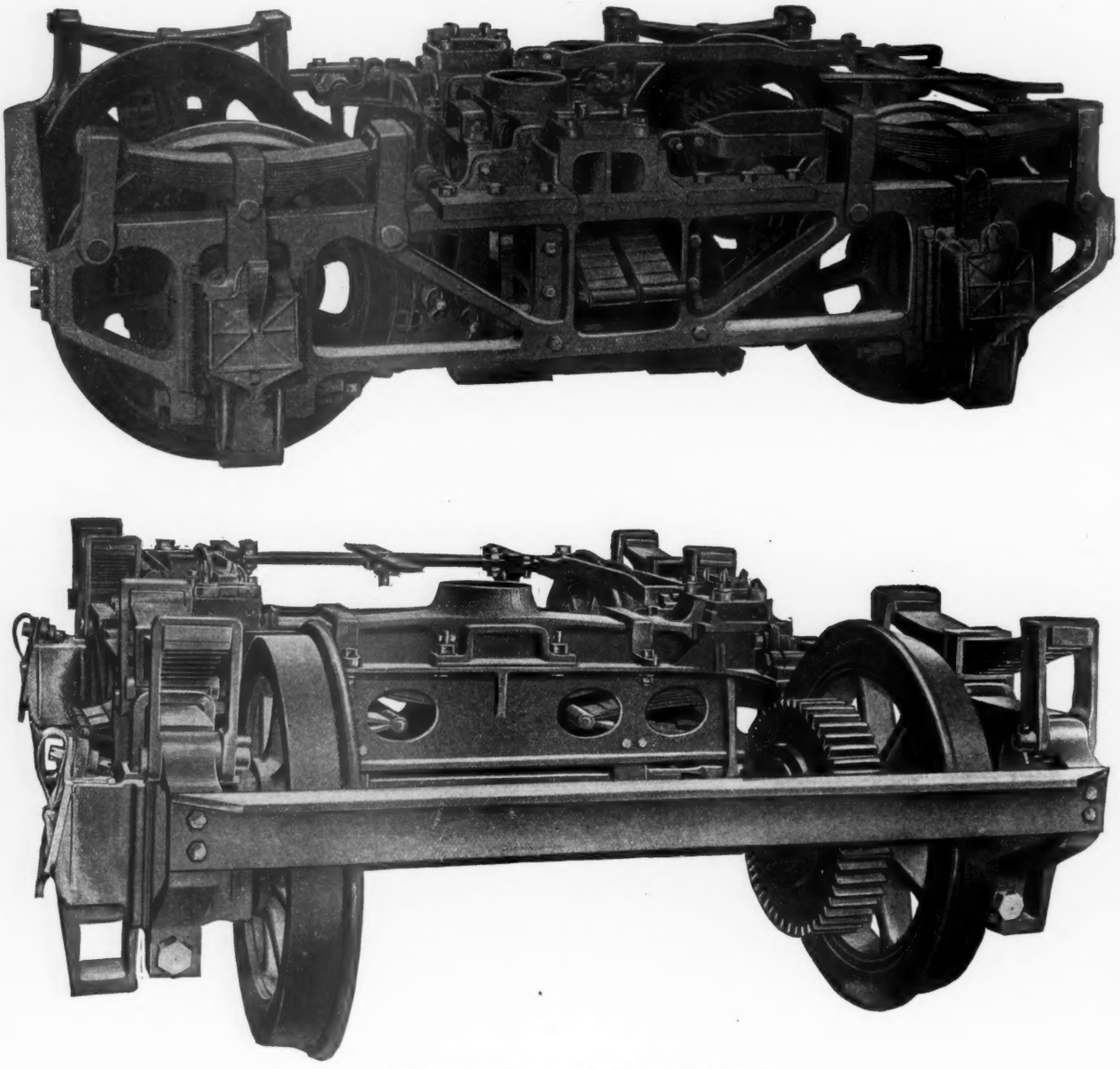
*(To be continued.)*

GENERAL DIMENSIONS OF STANDARD LOCOMOTIVES, CANADIAN PACIFIC RAILWAY.

| CLASS. | M-4 | D-10 | D-11 | G-2 |
|---|---|---|---|---|
| Service | Fgt. | Fgt. & Pass. | Fgt. & Pass. | Passenger |
| Fuel | Bit. Coal | Bit. Coal | Culm | Bit. Coal |
| Tractive power | 36,800 lbs. | 33,300 lbs. | 33,300 lbs. | 30,400 lbs. |
| Weight in working order | 186,200 lbs. | 190,000 lbs. | 192,000 lbs. | 214,300 lbs. |
| Weight on drivers | 163,700 lbs. | 141,000 lbs. | 141,000 lbs. | 139,300 lbs. |
| Weight on leading truck | 22,525 lbs. | 49,000 lbs. | 51,000 lbs. | 40,000 lbs. |
| Weight on trailing truck | ..... | ..... | ..... | 35,000 lbs. |
| Weight of engine and tender in working order | 307,650 lbs. | 312,700 lbs. | 314,700 lbs. | 337,000 lbs. |
| Wheel base, driving | 15 ft. 10 in. | 14 ft. 10 ins. | 14 ft. 10 in. | 13 ft. 0 ins. |
| Wheel base, total | 24 ft. 4½ in. | 26 ft. 1 in. | 26 ft. 1 in. | 33 ft. 7 ins. |
| Wheel base, engine and tender | 53 ft. 4¼ in. | 54 ft. 6¾ ins. | 52 ft. 11¼ ins. | 59 ft. 11¾ ins. |
| RATIOS. | | | | |
| Weight on drivers ÷ tractive effort | 4.45 | 4.24 | 4.24 | 4.6 |
| Total weight ÷ tractive effort | 5.06 | 5.7 | 5.72 | 7.05 |
| Tractive effort x diam. drivers ÷ heating surface | 880 | 870 | 905 | 670 |
| Total heating surface ÷ grate area | 55.5 | 49.2 | 30.4 | 62.5 |
| Tube heating surface ÷ firebox heating surface | 13.4 | 12.4 | 11.3 | 15.3 |
| Weight on drivers ÷ total heating surface | 68.7 | 58. | 61 | 44.6 |
| Total weight ÷ total heating surface | 78.1 | 78.7 | 83 | 68.7 |
| Volume both cylinders | 11.22 cu. ft. | 11.22 cu. ft. | 11.22 cu. ft. | 11.22 cu. ft. |
| Total heating surface ÷ vol. cylinders | 212 | 215 | 206 | 278 |
| Grate area ÷ vol. cylinders | 3.83 | 4.37 | 6.78 | 4.46 |
| CYLINDERS. | | | | |
| Kind | Simple | Simple | Simple | Simple |
| Diameter and stroke | 21 x 28 ins. | 21 x 28 ins. | 21 x 28 ins. | 21 x 28 ins. |
| VALVES. | | | | |
| Kind | Piston | Piston | Piston | Piston |
| Diameter | 11 ins. | 11 ins. | 11 ins. | 11 ins. |
| WHEELS. | | | | |
| Driving, diameter over tires | 57 ins. | 63 | 63 | 69 ins. |
| Driving journals, main, diameter and length | 9½ x 12 ins. | 9½ x 12 ins. | 9½ x 12 ins. | 9½ x 12 ins. |
| Driving journals, others, diameter and length | 9 x 12 ins | 9 x 12 ins. | 9 x 12 ins. | 9 x 12 ins. |
| Engine truck wheels, diameter | 31 ins. | 31 ins. | 31 ins. | 30 ins. |
| Engine truck journals | 6 x 10 ins. | 6 x 10 ins. | 6 x 10 ins. | 6 x 10 ins |
| Trailing truck wheels, diameter | ..... | ..... | ..... | 44 ins. |
| Trailing truck, journals | ..... | ..... | ..... | 7 x 14 ins. |
| BOILER. | | | | |
| Working pressure | 200 lbs. | 200 lbs. | 200 lbs. | 200 lbs. |
| Outside diameter of first ring | 69 ins. | 60⅝ ins. | 60⅝ ins. | 66 ins. |
| Firebox, width and length | 65¼ x 96⅝ ins. | 69⅞ x 102⅛ ins. | 100 x 110 ins. | 67⅞ x 102⅛ ins. |
| Firebox, water space | F5½, S4½, B3½ | 5½-4½-3½ ins. | ..... | ..... |
| Tubes, number and outside diameter | 22 & 244-5 & 2 in. | 266-2 in. | 244-2, 22-5 ins. | 209-2¼, 22-5 ins. |
| Tubes, length | 14 ft. 1⅝ in. | 14 ft. 2⅞ ins. | 13 ft. 7⅛ ins. | 20 ft. 0 ins. |
| Heating surface, tubes | 2,216 sq. ft. | 2,233 sq. ft. | 2,125 sq. ft. | 2,931 sq. ft. |
| Heating surface, firebox | 165 sq. ft. | 180 sq. ft. | 188 sq. ft. | 191 sq. ft. |
| Heating surface, total | 2,381 sq. ft. | 2,413 sq. ft. | 2,313 sq .ft. | 3,122 sq. ft. |
| Superheater heating surface | 375 sq. ft. | 378 sq. ft. | 307 sq. ft. | 530 sq. ft. |
| Grate area | 43 sq. ft. | 49.5 sq. ft. | 76.25 sq. ft. | 48 sq. ft. |
| Smokestack, diameter | 16½ ins. | 14½ ins. | 14½ ins. | 14½ ins. |
| Smokestack, height above rail | 15 ft. 1 3-16 ins. | 15 ft. 2 ins. | 15 ft. 2 ins. | 15 ft. 3-16 ins. |
| Centre of boiler above rail | 9 ft. 3½ ins. | 9 ft. 5½ ins. | 9 ft. 5½ ins. | 9 ft. 4 ins. |
| TENDER. | | | | |
| Weight, light | 51,450 | 52,700 | ..... | 52,700 |
| Wheels, diameter | 33 ins. | 33 ins. | 33 ins. | 34 ins. |
| Journals, diameter and length | 5½ x 10 ins. | 5½ x 10 ins. | 5½ x 10 ins | 5½ x 10 ins |
| Water capacity | 5,000 gals. | 5,000 gals. | 5,000 gals. | 5,000 gals. |
| Coal capacity | 10 tons. | 10 tons. | 10 tons | 10 ton |

## MOTOR AND TRAILER TRUCKS FOR THE NEW YORK CENTRAL ELECTRIC SERVICE.

The accompanying illustrations show the motor and trailer trucks for the suburban electric cars now being built for the New York Central & Hudson River Railroad. The design of both trucks, and especially of the motor truck, is radically different from that of trucks now used under electric cars in this country. They are notable because of their simple design, the small number of parts and the substantial construction. In these respects they correspond more nearly to the trucks used under our heavier passenger cars, and the cost of maintenance should be low. The design of the motor truck is similar to that of the trucks furnished to the Paris-Orleans Railway of France by the American Locomotive Company several years ago, which have given very satisfactory results in service. The motor truck with gears weighs 15,000 lbs., and complete with the two 200 h.p. motors, one on each axle, it weighs 26,760 lbs. The trailer truck weighs 11,400 lbs. The estimated light weight of the car complete is 102,600 lbs.

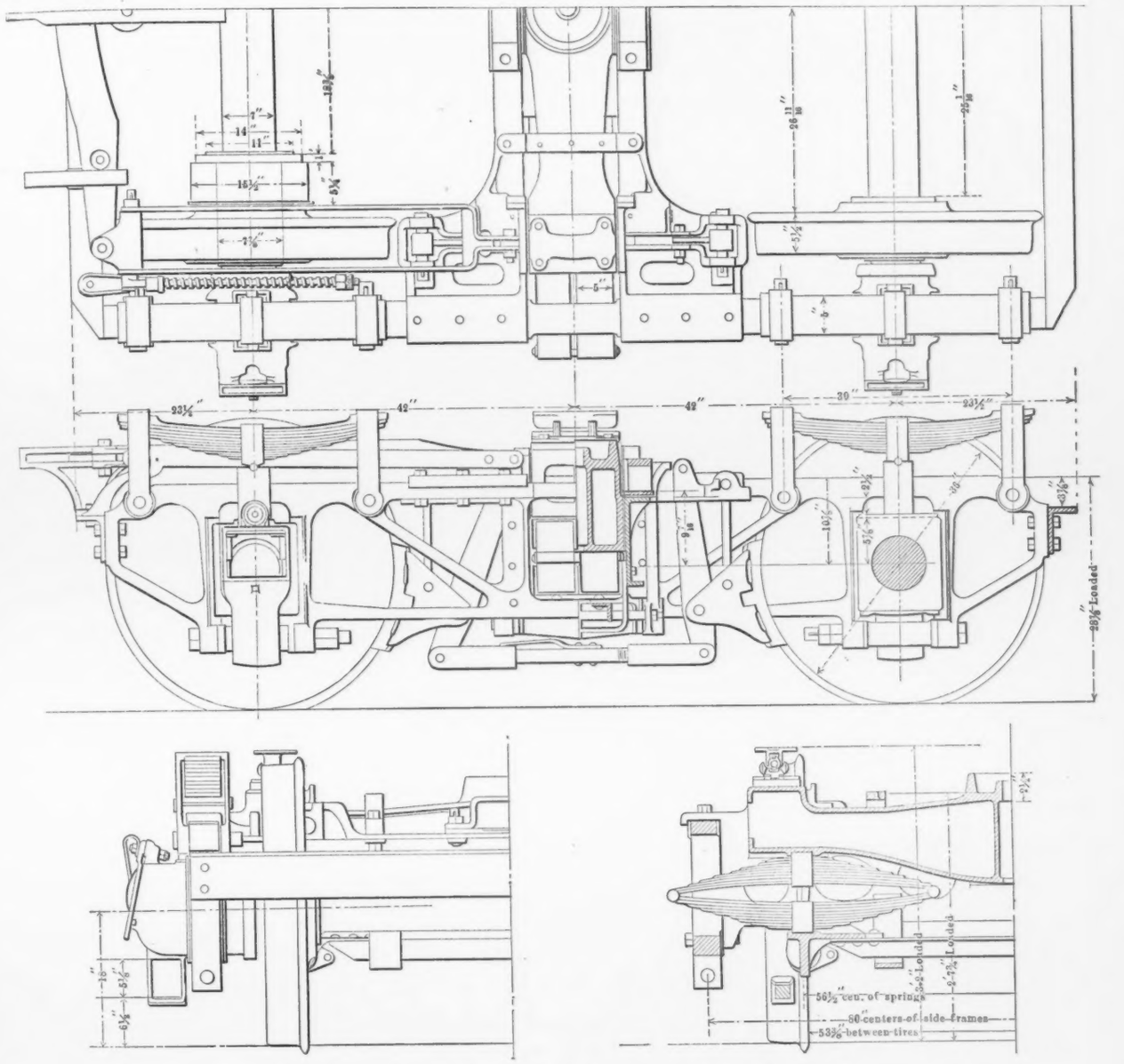


VIEWS OF NEW YORK CENTRAL MOTOR TRUCK.

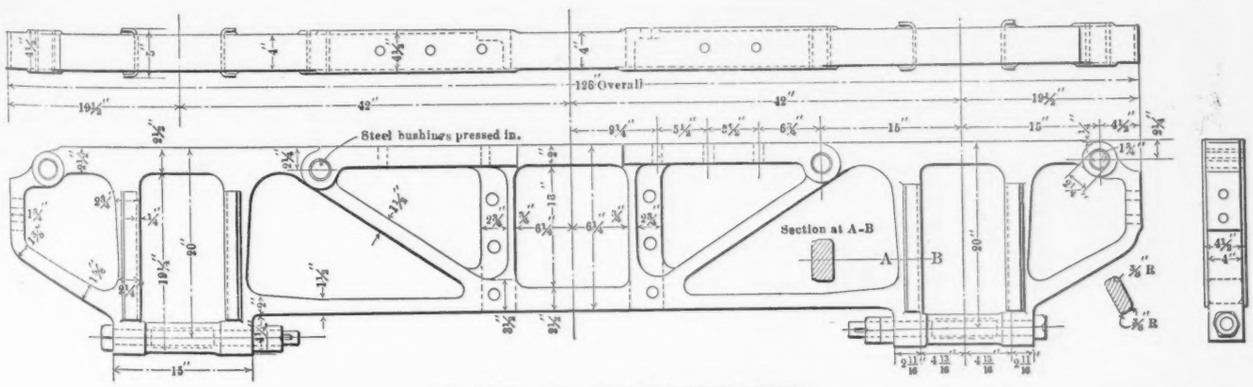
### MOTOR TRUCKS.

The motor trucks have a wheel base of 7 ft. and are equipped with steel-tired wheels 36 ins. in diameter. The design of the cast-steel side frame, the absence of equalizers, the method of spring suspension and the application of the journal boxes are in many respects similar to corresponding features in locomotive construction. The absence of equalizers and the open design of the side frame make it possible to readily give the truck a careful inspection when in service. The cast-steel side frame, shown in detail in one of the drawings, is designed for a low-fibre stress in all parts. The pin holes are fitted with 2¼-in. steel bushings. The frames are tied together at the ends by 4 by 6 by ½ in. angles.

The cast-steel transoms are of channel section 11½ ins. high at the centre and ⅝ in. thick; the upper flanges are 3½ ins. wide and the lower ones 2¾ ins. Near the ends the top flange is widened out to form a bracket for the suspension of the spring and brake hangers. This bracket is so designed that the end of the spring hanger is slipped into a cavity from underneath and is thus covered over, preventing dirt from getting on the bearing. A flange near each end of the transom projects upward, providing a larger chafing surface for the bolster, which at this point is of extra depth, and prevents it from binding. At the end of the transom is a bracket for attachment to the vertical bar of the side frame and the top



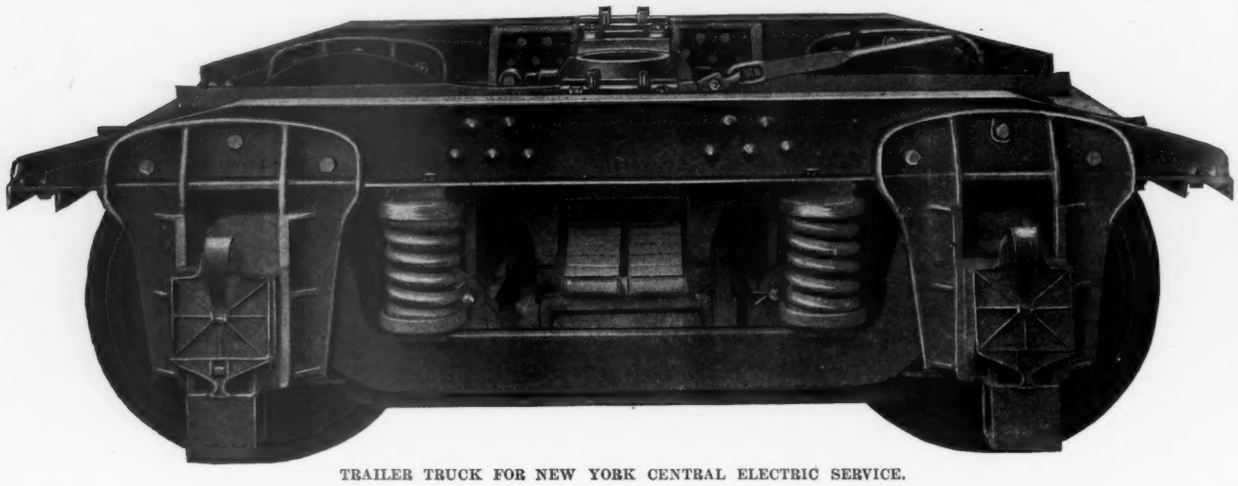

MOTOR TRUCK—NEW YORK CENTRAL & HUDSON RIVER RAILROAD.




CAST STEEL SIDE FRAME—MOTOR TRUCK.

of the transom lips over the top of the side frame, thus taking the strain off the bolts, which secure it to the side frame, and reducing the number of bolts required to a minimum. The transom at the centre is just high enough to take the motor nose (the motor application is not shown on the engravings), which rests on a case-hardened plate, held in place by the same bolts which secure the strap for the motor nose.

The cast-steel bolster is of I section and for a short distance at the middle and ends is of a double box section. No chafing plates are used, but the wearing surfaces at both the middle and ends of the bolsters are very large, so that the wear will probably be very slight, and as these surfaces are comparatively deep and the clearance between the bolster and the transoms is only ⅛ in., there will be no tendency for the bolster to cant or bind. The bolster is 11½ ins. deep at the centre and 6 ins. at the ends, except where it is raised to take

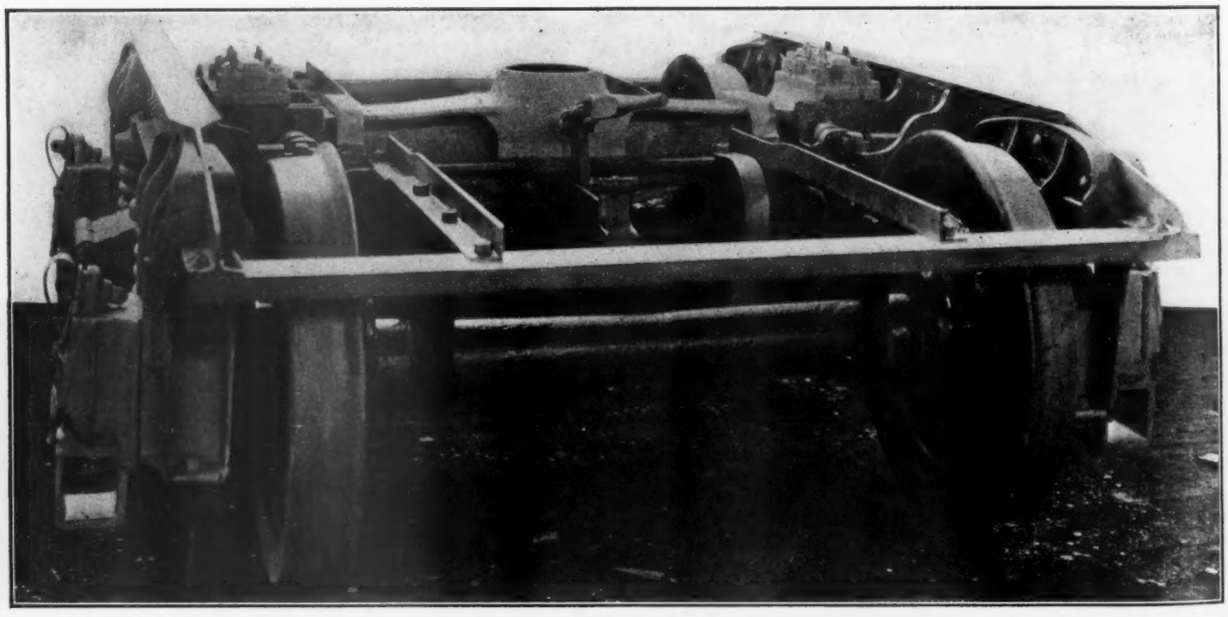


TRAILER TRUCK FOR NEW YORK CENTRAL ELECTRIC SERVICE.

the Norwood side bearings. The centre plates are cast integral with the bolster and the wearing surfaces are machined.

The spring plank is suspended from the brackets on the transoms by 1 by 1½ in. steel bars. The ends of the spring plank are steel castings, which are connected by two 2½ by 2½ by ⅜ in. angles, to which they are riveted. Trunnions are cast on these castings and are fitted with case-hardened sleeves, which are pressed on. The swing links slip over these sleeves. Because of the small amount of clearance it is impossible to extend the trunnions far enough to take a key and lugs are therefore forged on the links and they are tied together by a 1-in. bolt, as shown. The spring bands fit into recesses in the spring plank and bolster castings.

Symington journal boxes are used. The lower ends of the pedestal jaws are tied together by binders similar



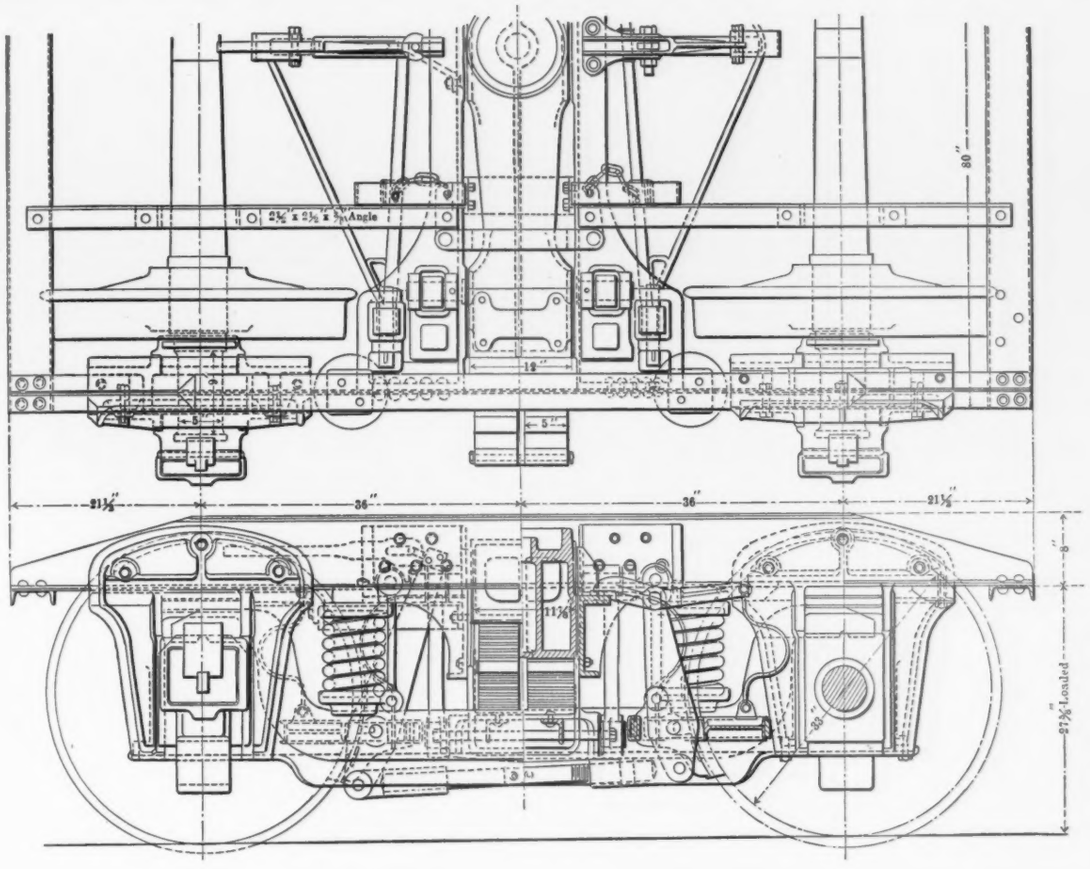
TRAILER TRUCK FOR NEW YORK CENTRAL ELECTRIC SERVICE.

to those used in locomotive construction. The shoes are made of ¼-in. steel pressed to shape, and as they fit tightly on the jaws no bolts are required and they do not rattle. A U-shaped piece of 1 by 4 in. steel bar passes over the frame and rests on top of the journal box; it has a 1-in. pin, resting in the milled slot at the top, which supports the spring band. The projections or lugs at the lower front part of the journal boxes are designed to take 4 by 6 in. beams, to which the third rail shoes are to be attached. The journal brasses and wedges are standard for the 5½ by 10 in. journal, except that the ends of the brasses are brought down ⅜ in. lower than usual in order to better withstand the thrust of the motors. The axles have an enlarged wheel fit 7⅞ ins. in diameter. A projection is cast on the inside of the wheel over which the large gear, which is cut from hard rolled steel similar to tire steel, is shrunk on. Steel gears of this kind give much more satisfactory results than castings.

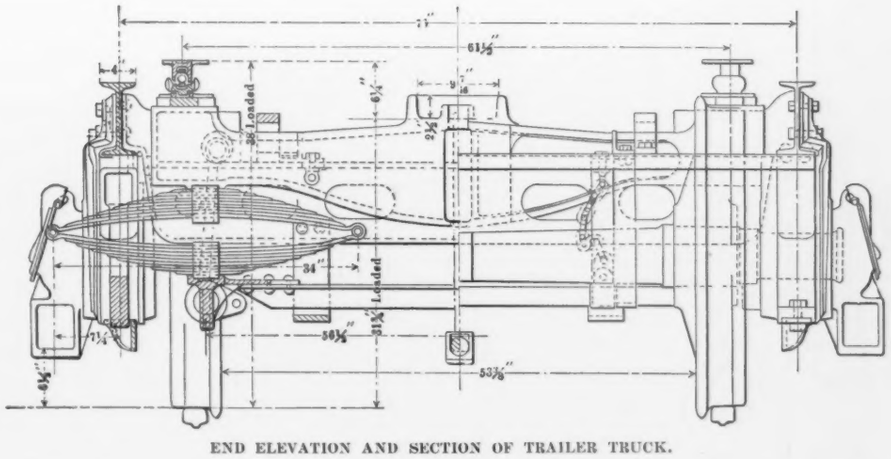
The space occupied by the motor does not allow the use of brake beams, and each brake-head is therefore hung individually from the brackets cast on the transoms. The lower ends of the two brake levers on each side are connected by turnbuckles for the adjustment of the brakes. The turnbuckle studs are of square section and are locked at each quarter turn by the flat spring shown in the illustrations. The levers at each side of the truck are connected by loop bars, which straddle the wheels, to the ends of a cross bar, which is 1 by 5½ ins. in section at the centre. This bar is supported and guided by two castings attached to the angle which connects the side frames. The connection to the main brake rod is unique and is designed to reduce the strains on the rods when the car is on a curve. A roller is fitted in the fork of the main rod and bears against the curved surface of the cross bar. The spiral springs attached to either end of the bar return the brakes to the release position.

TRAILER TRUCK.

The trailer truck has a wheel base of 6 ft. and is equipped with 33-in. steel-tired wheels. The general design is quite similar to that of the four-wheel metal trucks used on the




PLAN AND SIDE ELEVATION OF TRAILER TRUCK.



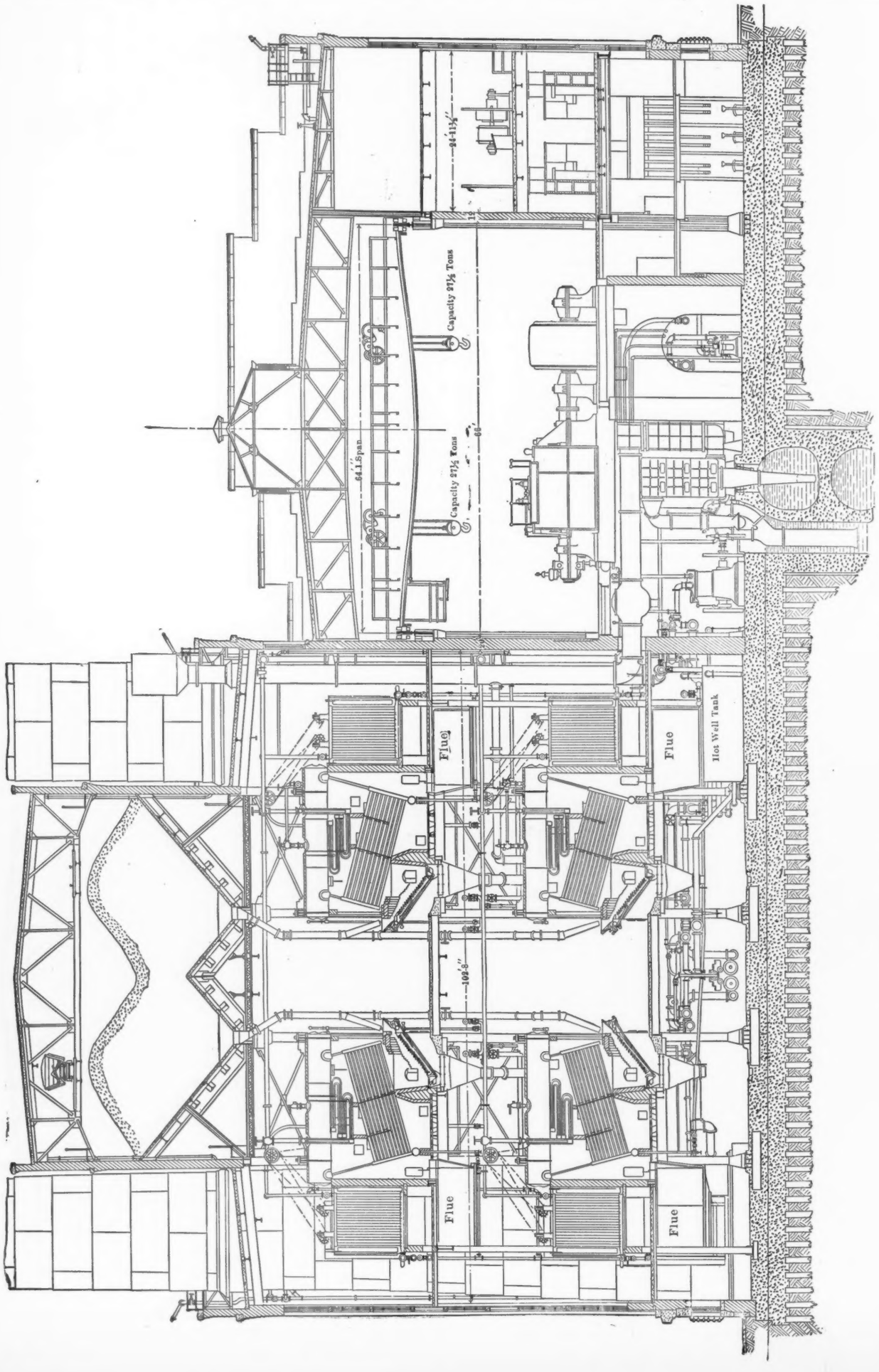

END ELEVATION AND SECTION OF TRAILER TRUCK.

New York Central Lines, which are giving very satisfactory results for heavy passenger service. The engravings illustrate the truck so clearly that a brief description will suffice. The side member is an 8-in. I beam, to which the pedestal castings are bolted. The pedestals are tied at the lower ends by a light strap. The equalizer bars are of the usual design. The side members are connected at the ends by 5-in. channels. The bolster is the same as the one used on the motor truck. The transoms are of cast-steel and are also quite similar to those used on the motor truck, except for slight differences in the design of the brackets for suspending the spring plank and brake hangers and also of the brackets at the ends for attachment to the side frame. The spring plank is of the same construction as the one on the motor truck.

The axles are M. C. B. standard with 5 by 9 in. journals. Symington journal boxes are used with a lug cast at the lower front end for carrying the beam to which the third rail shoes are attached. The application of the brake rigging is clearly shown in the drawings. The trussed brake beam, designed by the American Locomotive Company, consists of two rectangular bars which are welded together at their ends.

The motor trucks were designed by the American Locomotive Company in consultation with the motive power department of the New York Central & Hudson River Railroad and the trailer trucks are adapted from designs of similar trucks which have been in service on the New York Central Lines for several years.

A VALUABLE TOOL FOR ROUNDHOUSES.—In addition to the list of tools that Mr. Bentley has enumerated for the roundhouse, we have discovered in the past year that a small lathe mounted on a wagon that can be drawn to any pit in the roundhouse by a couple of men, and has been a very good investment. We drive it with an air motor. With the class of power that we have we find it necessary very frequently to renew splice bolts in frames and such as that, and this lathe we use for the purpose of fitting the bolts right on the ground. Say we have an engine around in the fiftieth stall; we draw the lathe around there, and the bolts are taken there in the rough and are turned and driven in right at the spot. We find that an advantage over carrying the bolts to some place in the shop and then back again to be tried, and a little more taken off from them, and finally driven in where they belong, sometimes tight, and sometimes not as tight as they should be.—*Mr. D. R. MacBain, before Western Railway Club.*




CROSS SECTION OF POWER HOUSE AT LONG ISLAND CITY.—PENNSYLVANIA, NEW YORK & LONG ISLAND RAILROAD.

## THE PENNSYLVANIA RAILROAD'S EXTENSION TO NEW YORK AND LONG ISLAND.

### LONG ISLAND CITY POWER HOUSE.

The Pennsylvania Railroad Company has had plans for establishing a terminal for its lines on Manhattan Island under consideration for a number of years, and at present has all parts of the work of tunneling under the Hudson River, the Island of Manhattan and the East River and the erection of a very large passenger station in New York City under way. The earliest plans for entrance onto the island contemplated a bridge over the Hudson River, but the thorough demonstration that electric traction is practical for heavy train units made possible the many advantages of entering the city by means of tunnels. The plan, as finally rounded out and being followed, embraces not only a Pennsylvania terminal on the island, but also a through connection with New England and the railroad system of Long Island. The first announcement that this plan had been adopted was made in May, 1902, and since that date the project in all its features has been actively under way, and at a recent date the first link in this great work, the Long Island City power station, was completed.

In this and future articles we propose to take up and describe such features of this power station, the transmission line and the new rolling equipment, as will be of interest from a mechanical and electrical point of view.

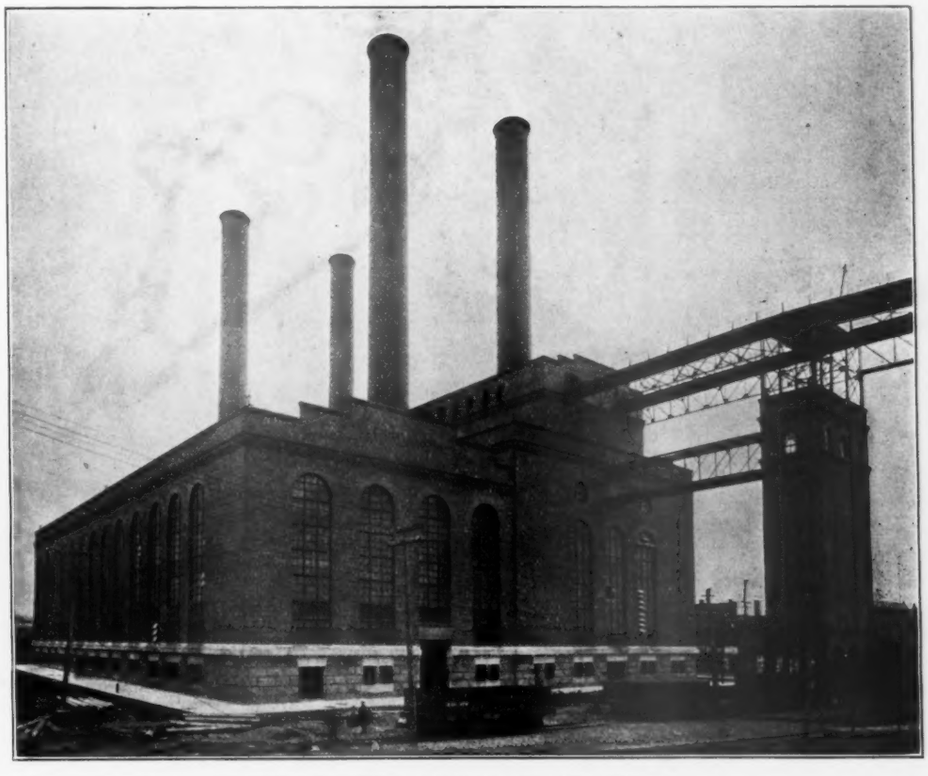
This power station is an example of the most modern design of a source of power for heavy electric traction, and includes in its equipment the latest features of steam generating and converting apparatus as well as electric distributing and controlling methods. Briefly, it consists at present of 32 Babcock and Wilcox water tube boilers set in batteries of two boilers each, eight batteries on the first floor and eight on the second floor immediately over them; three 5,500 k.w. generating units driven by Westinghouse-Parsons steam turbines delivering alternating current at 11,000 volts, and high tension controlling devices connecting a simple but highly efficient distributing scheme to the high tension feeder cables leaving the power house. The unit system of installation has been followed throughout; that is to say, four batteries of boilers, two on the first and two on the second floor are connected directly to one generating unit, and each unit is to feed a certain part of the electrical distributing system when the plant is operating at full load. However, while the plant is designed on that general principle, the boilers, engines, generators and distributing system are so connected by cross-connections that the power house as a whole presents a very flexible arrangement, allowing any boiler, or number of boilers, to operate any generating unit, which will furnish current for any feeder cable or circuit.

LOCATION.—This station is located at Hunter's Point, Long Island City, adjacent to the bank of the East River and about opposite the foot of Thirty-fourth Street, New York City. This location was chosen for a number of reasons, principal among which was the close proximity to the East River, which permits a convenient and ample supply of circulating water for the condensers and cheap coal delivery. It is also at a point adjacent to this site that the tunnel under the East River will emerge and connect with the lines of the Long Island Railroad, the suburban sections of which are concentrated here. There is also a freight yard of the Long Island Railroad located at this point, which permits the cheap handling of both coal and ashes by rail, as well as a minimum expense for delivering building materials and equipment during construction.

STATION CAPACITY.—At the time the design was undertaken the extent of electrification in sight was such as to necessitate a station capacity of not less than 50,000 k.w. and probably more. The rectangular shape of the lot, practically 200 by 500 ft., made it possible to plan a station which could be built in sections and eventually occupy the whole block. The adopted design will finally permit of fourteen 5,500 k.w. generating units. However, as this amount of power will not be needed for some years to come, the station, as now built, consists of less than half of what the finished building will be, and has room for six 5,500 k.w. units and two 2,500 k.w. units of the same type, which will be used for lighting. At present but three of the main units have been installed.

#### BUILDING.

DIMENSIONS.—The present building, the general appearance and construction of which is clearly shown in the illustrations herewith, is 200 by 262 ft., outside measurement. It is divided into three distinct sections lengthwise, of which



VIEW OF POWER STATION AND ASH TOWER.

the boiler house, 103 ft. wide, is the largest. This section is 82 ft. high to the top of its parapet and has above it the coal pocket enclosure, which is 60 ft. wide with its parapet 118 ft. above the street level. The engine room and electrical galleries are located in the other main sections of the building, the former 66 ft. wide and the latter 25 ft. wide. This section is but 70 ft. high. The boiler house has two floors, the first of which is 16 ft. above the basement and the second 35 ft. above the first floor. In the engine room there is but one floor, which is 23 ft. 6 ins. above the basement. This room has a clear height of 40 ft. from the floor to the roof trusses. The electrical section has properly four floors, the second of which is on a level with the engine room floor. This sub-division includes the offices and a small machine shop as well as all of the electrical control apparatus.

FOUNDATIONS.—Underlying the whole building is a large monolith of concrete, which is nominally 6 ft. 6 ins. thick, and rests on piles closely driven over the whole area, the spacing being on an average 2 ft. 4 ins. between centres of piles. The total number of piles required for this work was 9,115. They are all driven practically to refusal, and designed to carry a load of 12 tons each. This type of foundation was chosen because it allows future loads to be adjusted to suit conditions, gives a uniformity of settlement throughout, and also that a careful study showed it to be cheaper than disconnected types of foundations on this kind of soil. The top of the piles are cut off 2 ft. 6 ins. below high water level and in a water bearing stratum of river mud which insures perpetual moisture. Underneath the stacks the concrete cap is 8 ft. 6 ins. deep, the piles being cut off 2 ft. lower down.

The flume for the condenser intake and the overflow flume directly above it, traverse the building foundation completely from west to east and are integral with it. Between the power house foundation and the river these two flumes separate so that the discharge is a considerable distance from the intake. Both of these flumes are nominally 10 ft. in diameter, which allows a low velocity of flow even when the power house is in its completed shape. Great care has been taken at the inlet to prevent any possible trouble from its being clogged either by ice or in any other manner, there being a heavy timber ice fender with timbers spaced 4 ins. apart and inclined toward the surface, behind which is a large well having two sets of screens fitted in vertical iron guides. The outer screen is of iron wire with 1 in. mesh and the inner one of copper wire with ½ in. mesh. To prevent any trouble with ice forming in the flume during extreme cold weather a 30-in. connection is taken from the overflow flume, which, if desired, can be opened and allow enough warm water to enter the intake well to prevent an accumulation of ice, even when there is a very moderate load on the power plant. These flumes are built entirely of concrete, being reinforced at such points as are necessary to prevent crushing.

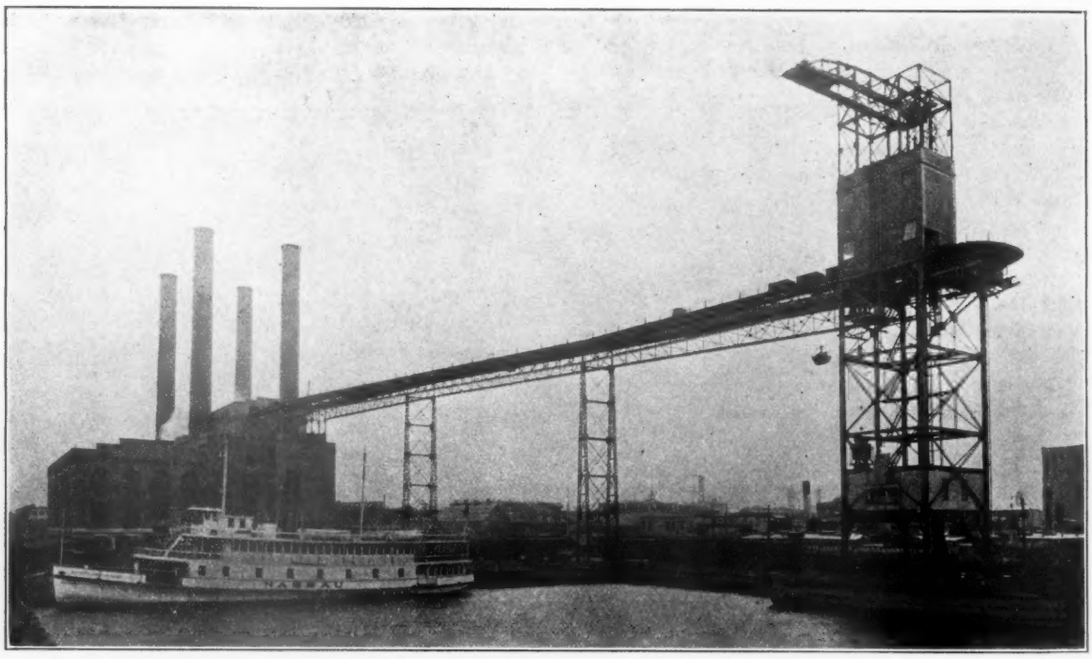
As the intake flume is underneath the overflow, a well is provided at each condenser base at one side of the overflow flume and connecting to the intake flume below. The condenser intake is located in this well and the condenser discharge drops directly into the overflow flume.

There is a total of 18,000 cu. ft. of concrete in the monolith cap and flume.

SUPERSTRUCTURE.—Like all modern buildings of this class the station consists of steel frame work enclosed in brick walls. The steel work is independent of the walls in this case, with the exception of the south end of the boiler house roof trusses, which are supported by the wall at that point.

The architectural treatment is of the simplest kind, there being nothing of an ornamental nature included. The general design comprises three distinct features, as will be seen from the exterior view, the first being the boiler house with its four independent stacks and its series of single arched window openings extending without interruption past all floors. The second feature is the separate enclosure of the coal bunkers, superimposed on the boiler house longitudinally between the stacks, and the third is the engine house, including also the electrical galleries and offices, which is treated as a separate wing of the main building, connected to and parallel with the boiler house but subordinate thereto. Similar long window openings divide the walls of this part into equal facades.

The arched facade of the superstructure rests upon a base-



VIEW FROM RIVER, SHOWING COAL HOISTING TOWER AND CABLE RAILWAY.

ment of rough hewn granite pierced with small heavy grated window openings. Above this the walls are constructed of red brick laid in white mortar. The ash bin, located directly in front of the boiler house, which is so situated in the freight yard that ashes can be dropped from it by gravity into gondola cars, is constructed to harmonize with the main building.

The roof and floors throughout the station building are of concrete reinforced on the Ransome system and carried by the steel frame work. The frames of all doors and windows in the exterior walls are of cast-iron, and so also are the window sashes, which are glazed with rough wire glass. All the sashes are pivoted at the top and arranged to swing outward by a system of operating devices specially designed for this station.

The steel work of the building carries the weight of the rooms and the inner contents, except such portions of the machinery as may be more conveniently carried on separate foundations. The framings for the boiler house and engine room are necessarily quite different in type, as the former has to carry a double tier of boilers with all their appliances, together with a coal pocket of 5,200 tons capacity on top of everything, while the engine room structure carries nothing

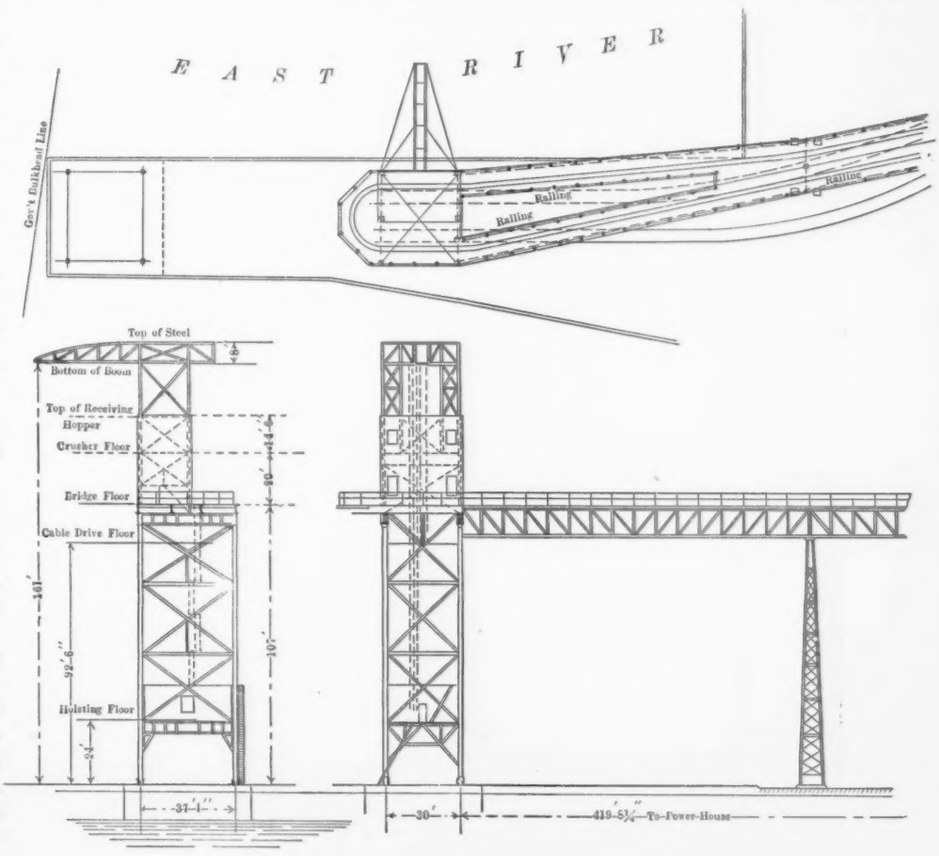
but the roof trusses in the engine room. The 55-ton traveling crane spanning the engine room is supported on separate columns.

The stacks are independent of the boiler house, except where they pass through the lower boiler room floor, at which point the floor is built around the stacks. At other points they pass through circular openings, so that there is no stress induced in the structure by a deflection of the stacks. A general idea of the whole steel structure can be obtained from an inspection of the cross-section of the station given herewith. The problem of supporting the large coal bin at such a height, and also of the boilers on the second floor, makes this structure interesting. The bottom of the columns supporting these heavy loads rest on grillages of steel beams imbedded directly in the monolith concrete foundations.

COAL AND ASH HANDLING PLANT.

The location of the power station is such that it can receive coal either by water or by rail, but it is expected that most of the supply will be delivered by water, and for handling this a most complete apparatus has been installed.

As shown in one of the illustrations, this consists of a high tower located on a dock about 500 ft. from the power house, and having a boom extending out over the water and a high cable railway connecting to the power house. In brief, the system consists of a clam-shell bucket, which is filled in a barge alongside the dock, hoisted to the boom and then trollied across to the centre of the tower, where it is automatically dumped into a hopper, from whence it passes through the crusher and into the cars on the scale platform below. These cars are carried by a cable railway across and into the boiler house at a height sufficient to allow them to be dumped into the coal bin by gravity. They are automatically dumped without stopping and need no attention until they again return for loading.




PLAN AND ELEVATION OF COAL HOISTING TOWER.

The coal hoisting tower consists essentially of four heavy corner columns of box pattern thoroughly braced to each other in all directions, excepting below the engine room floor, where the bracing is omitted in order to allow three railroad tracks on the dock to pass through the tower. The engine room floor is 25 ft. above the dock, and the space here for a height of 14 ft. is enclosed and forms an engine room for the hoisting apparatus. The tower extends in this shape to the level of the railway, which is 107 ft. above the dock; it then continues in a narrower section to a height of 170 ft. above the dock. This upper section carries the hoisting beam, receiving hopper, coal crushing and weighing apparatus and the cable railway machinery. The boom is 68 ft. long and projects 43½ ft. beyond the face of the tower and over the slip at an elevation of 162 ft. above the dock. It consists of two parallel trusses thoroughly braced and connected and carries the track for the trolley carriage from which the hoisting bucket is suspended.

Between this tower and the boiler house structure, a distance of 500 ft., there are four spans of bridge construction carrying the cable railway. Of the three piers required for these four spans, two are simple design of steel bents shaped like the letter A but elongated, and the third is formed by carrying up the steel structure required for the ash bin. The two outermost spans of this bridge are 140 ft. 6 ins. and the third is 149 ft. long, and the span from ash tower to the boiler house is 70 ft.

The ash bin consists of an enclosure of brick walls around the supporting steel columns. The bottom of the bin is 20 ft. above the railroad track which runs through the base of the tower, and the ashes are handled through dumping gates into gondolas standing on this track. The ashes are handled from the power house through a telpherage system, which hoists the buckets from the boiler room basement to the bridge, at an elevation of 69 ft. above the street, where they are automatically transferred across and dumped into the ash bin. The capacity of the bin is 300 tons.

The hoisting tower is what is called the "one-man" type, i. e., the hoisting and dumping machinery is all under the control of one man, who is situated in the engine room but a short distance above the barge from which the coal is being taken. The coal is hoisted in a 2-ton bucket, which is raised and lowered by a two-cylinder, 15x24-in. Lidgerwood type of hoisting engine with Stephenson link motion. The bucket is so counter-balanced that when lowered its speed cannot exceed 1,000 ft. per minute, although when hoisting its maximum speed is about 1,400 ft. per minute. The opening and closing of the bucket is done by a "biter" engine, which is of the 8x10-in. Lidgerwood type. This engine can also be used to drive a winch on the dock. The trolley motion for running the bucket in and out along the boom is operated by a 6x8-in. Lidgerwood engine.

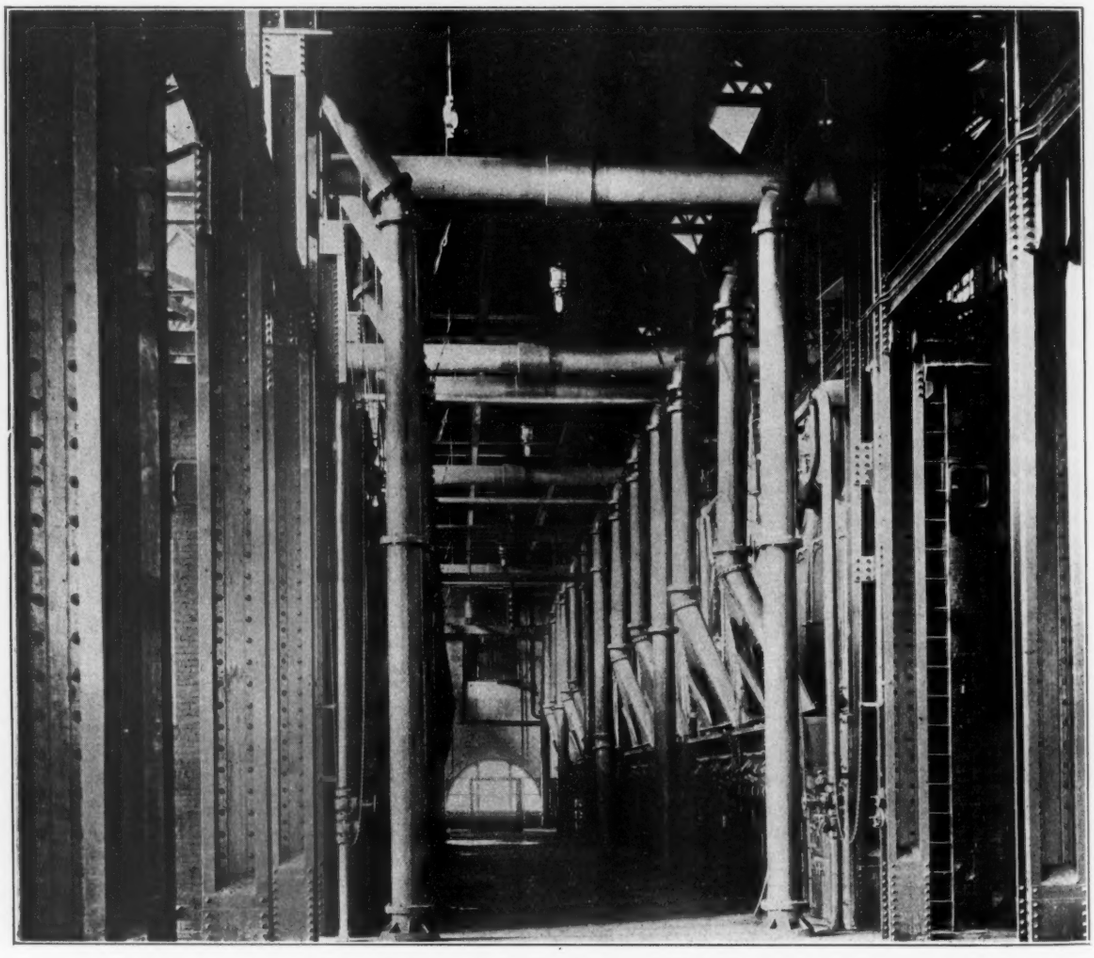
The complete operation is as follows: The bucket is lowered into the barge with the jaws open and the sharp edges of the bucket dig into the coal to a sufficient depth to allow the enclosure of a full load as soon as the jaws are closed. The closing of the jaws is done by the "biter" engine, which operates through a series of steel ropes working around sheaves, and brings the jaws of the bucket together without lifting it out of the barge. When the pocket is closed the hoisting engine starts automatically and continues hoisting until the bucket reaches its predetermined height of about 150 ft. in the air, where the hoisting ceases and the trolley motion

starts automatically, running the bucket along the boom until it is over the receiving hopper, and then automatically starting the "biter" mechanism in the reverse direction and dumps the load. The return movement is controlled by the operator. Full sets of limiting and safety devices, as well as indicators in the engine room, are installed. The bucket can complete a round trip in 45 seconds. The machinery for hoisting and trolleying was designed and built by the Robins Conveyor Belt Company.

The receiving hopper is built of steel plate and the coal passes through it by gravity to a shaking bottom, which allows certain small bituminous or anthracite coal to pass around the crusher to the loading hopper and delivers the large coal to the crusher below which has a capacity of 400 tons in five hours. The cable railway is capable of handling 150 tons per hour when operating twenty-nine 2 ton cars at a speed of 180 ft. per minute around the track loop. However, there are at present but 10 cars in operation. These are of the side dump type, the sides being designed to swing outward and the bottom being inclined so that the car entirely clears itself upon the opening of the side doors. The tripping device, which automatically dumps the car above the bin, consists simply of a heavy cam bolted to an I beam running directly over the centre of the track. This cam engages an arm projecting up from the car, thus actuating the dumping mechanism. These cams can be located as desired.

The cars are propelled by a ¾ in. six strand wire cable, which is gripped by a simple design of gripping mechanism. The cable is driven by a 7½ by 7 in. Westinghouse engine. This engine is automatically shut down in case cars are not properly released from the cable, which is done automatically at a point near the loading platform, where the cable leaves the roadway and goes over the winding drum.

The ashes are dumped through hoppers in the bottom of the stoker pits into small cars, so constructed that the body is detachable from the truck. After receiving its load the car is run along a narrow gauge railway to a turntable at the west end of the boiler house basement directly under the end of the ash bridge extending into the building. They are then fastened on to the telpherage hoist, which upon being started, automatically hoists them to the height of a 10 in. I beam, which forms the track from the ash bin into the boiler house. It then carries them across, automatically dumping into the ash bin, reverses and returns again to the inner end of the track and lowers to the turntable. The entire cycle of operation is effected by simply throwing the starting switch. However, arrangements have been made for stopping and reversing at any desired point. The time required for one round trip of the bucket, hoisting one ton of ashes from the basement to the ash bin and return, is about 3½ minutes. Proper safety devices are installed wherever necessary.



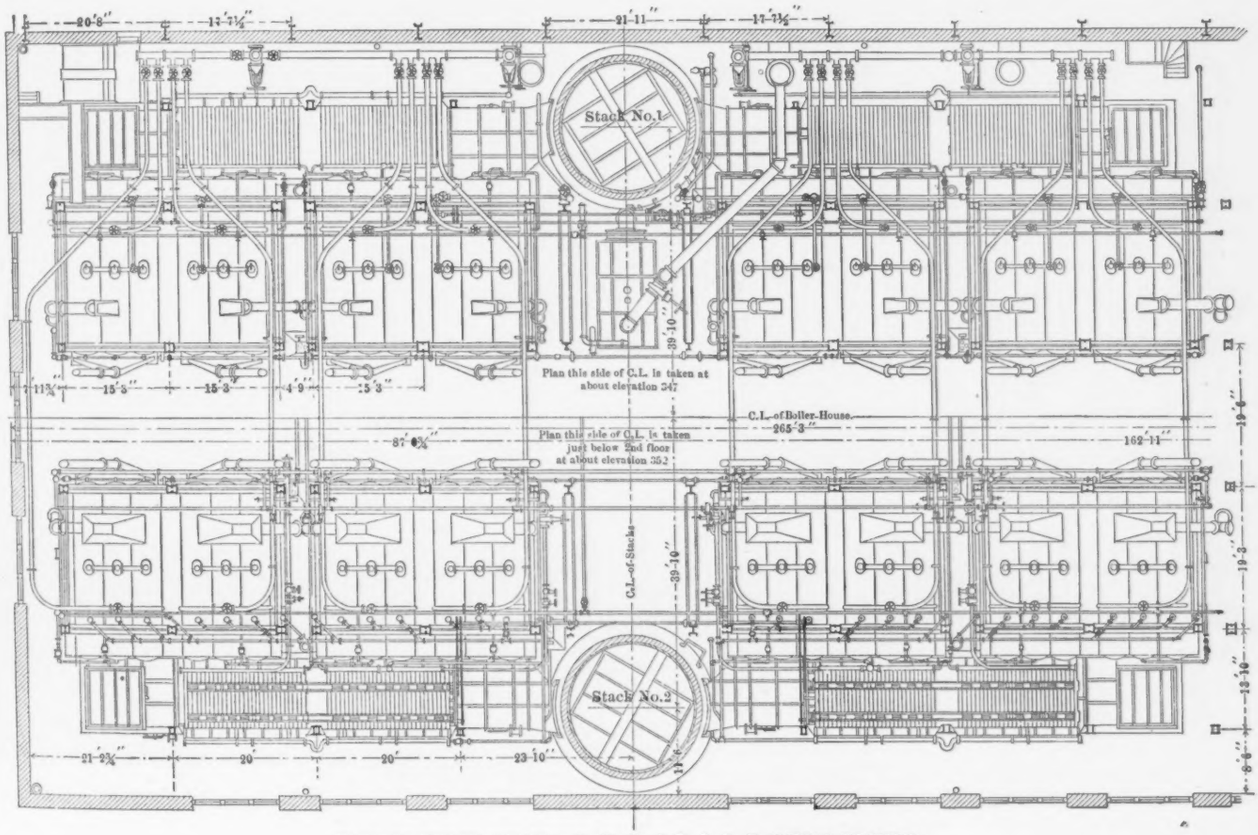
VIEW OF BOILER FRONTS, SECOND FLOOR.

STEAM GENERATING PLANT.

As was mentioned above and can be seen by the cross section of the plant, the 32 Babcock and Wilcox boilers at present installed are equally divided between two floors and being connected two boilers to a battery gives 8 batteries on the first floor and 8 on the second. These batteries are equally distributed on each side of the plant, all facing on a firing space about 18 ft. in width. One of the interior views shows the appearance of this passage. The boilers are designed for a working pressure of 200 lbs. per sq. in. and each boiler has a total heating surface of 5,243 sq. ft. Each boiler also includes an internal superheater consisting of two sections of tubing arranged like a letter U lying on its side and comprising about 1,116 sq. ft. of superheating surface. Each superheater is capable of superheating the output of a boiler

200 degs. F. at 200 lbs. pressure. Provision is made for flooding the superheater when it is out of service. The sections and drums comprising the boilers are hung from wrought iron I beams framed into the building and are thus suspended entirely independently of the brick work. Each boiler has two steam openings, the main nozzle receiving steam from the superheater and the auxiliary nozzle taking saturated steam directly out of the top of the boiler drums.

Each boiler is fitted with a Roney stoker 150 inches wide and having 24 grate bars. The coal supply is fed into a hopper on the boiler front by gravity from the bins above, the connection being made by cast iron piping with suitable valves for controlling the supply. The ashes drop into receiving hoppers at the bottom of the grate and thence discharge through cast iron pipes to openings above the narrow gauge tracks in the basement, from whence the ash cars can be filled. The disposition of the hot gases after leaving the boilers have been very carefully worked out and the arrangement of flues, economizer chambers and dampers is such that while it is intended to work on the unit system, that is by working four




PLAN OF BOILER HOUSE.—P. N. Y. & L. I. R. R. POWER STATION.

boilers together on an economizer directly behind them and thence directly to the stack, the flexibility of the arrangement is so great that it is possible to connect any boiler or number of boilers to any economizer or number of economizers and discharge to any stack, or if desired all the economizers can be cut out and the gases escape direct to the stack.

The economizers are directly behind the boilers and over the flues and each consists of 56 sections of 10 tubes each. The rear wall of the economizer chamber is made of vitrified asbestos air cell board in section, so that in the event of a broken economizer tube it is not necessary to tear down any of the brick work. By the use of these economizers the hot gases are so reduced in temperature as to reach the base of the stack at about 350 degs.

Stacks.—There are four stacks in the present station, although the present equipment uses but two. When the station is extended the number will ultimately be six. The stacks are built of steel, are entirely self-supporting and measure 275 ft. in height. The inside diameter of the straight portion being 17 ft. 10 ins. at the bottom and 16 ft. at the top. They are lined throughout with brick, the spaces between the brick lining and the steel stack being filled with cement mortar. The plates are steel and vary in thickness by sixteenths, from ½ in. at the bottom to 5-16 at the top. Each ring is a cylinder, the lower plates being outside of the upper and each joint carefully caulked. The stack flares at the base and rests upon a cast iron ring 23 ft. in diameter, which in turn is fastened directly to the concrete foundation.

Feed Water.—The nominal feed water supply to the boilers comes from the hot wells, which receive their water from the main condensers. It is taken from the wells by four boiler feed pumps located in the center of the boiler house basement. The pumps have compound steam ends with steam cylinders 14 and 22 ins. in diameter, the water cylinder being 12 ins. in diameter and 24 in. stroke. The pumps discharge into a pipe making a loop around the ceiling of the pump room and are so connected that they will discharge into either side of the loop, enabling any pump to be cut out for repairs. This loop discharges into the closed heaters, of which there are two, each containing 1,000 sq. ft. of copper tube heating surface. These heaters are supplied with exhaust steam from the auxiliary engines. From the closed heaters the water passes through the economizers and from thence into a loop over the boilers, from which each boiler receives its supply.

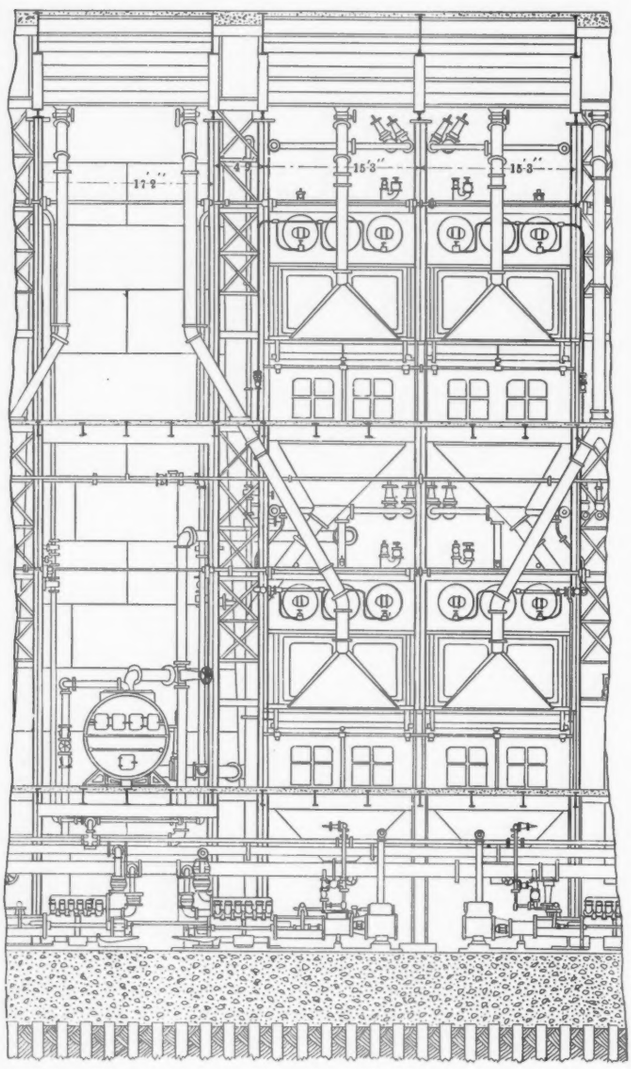
Special provision has been made to always have on hand a reliable water supply and for that purpose a stand pipe 40 ft. in diameter and 80 ft. high is connected into the 18 in. main of the Montauk Water Company, which leads to the power house. From this 18 in. main, which parallels the building, two 14 in. branches are taken off, and connected into a loop in the inside of the building. From these, in case of an emergency, the boiler feed pumps can obtain their supply. However, under ordinary circumstances this is needed only as "make up" water for the hot wells.

The hot wells, of which there are two for each generating unit, are in the form of open steel tanks about 12 ft. sq. and 6 ft. 6 ins. deep. The water level is maintained constant by a float valve in the tank actuating the governor on the pump

connected to the main water supply. This make up water goes directly from the mains to an open Cochrane feed water heater and purifier, which utilizes the exhaust steam from the double acting auxiliary engines and reciprocating pumps. This heater is very large in order to insure slow circulation and is really more of a purifier than a heater. The make up water can, if desired, be used for cooling purposes about the building on its way to the hot wells instead of passing through the heater. Nominally the make up water runs from 10 to 15 per cent. of the entire water consumption of the plant.

MAIN STEAM PIPING.—In general the piping for the whole plant is laid out to conform to the lines of the unit system above mentioned, but these units are so interconnected that the greatest possible flexibility is allowed and permits any boilers to be operated and furnish steam for any particular generating unit.

The general arrangement of the superheated steam piping is such that the four boilers on each floor connect unto a manifold and each two manifolds are connected together and



ELEVATION OF BOILERS.

fed into the main steam pipe for one generating unit. A cross connecting or equalizing header connects the different manifolds.

The supports for the main steam piping consist simply of turn-buckle rods suspended from the steel work of the building, the arrangement being such as to afford opportunity for expansion in any direction. The manifolds are supported on springs resting on a platform suspended from the building beams.

There is a system of saturated steam piping for supplying the steam to the steam driven auxiliaries, including the boiler feed pumps, circulating pumps, stoker engines, etc., which is taken only from the boilers located on the engine room side of the boiler house. This steam line forms a loop in the basement, one side being in the boiler house and the other in the engine room basement and having cross connections and proper valves to permit cutting off any particular part.

The piping of all kinds throughout the station is painted in different colors, a distinct color being given to each separate line, i. e., white indicates high pressure steam lines; bright red with black flanges indicates saturated steam lines and Holley system connections; black, boiler feed piping; yellow, exhaust from auxiliary apparatus, etc.

ENGINE ROOM EQUIPMENT.

As stated above, the space in the engine room provides for seven 5,500 k.w. generating units and two 2,500 k.w. lighting units. However, at present but three of the larger units have been installed. These consist of Westinghouse-Parsons steam turbines direct connected to Westinghouse alternating generators of the revolving field type.

The general appearance of the engine room is shown in one of the illustrations herewith and in it the remarkable absence of piping or other obstructions of the floor space will be noticed. The room is spanned by a 55 ton electric crane having two hoists, which was built by the Morgan Engineering Company. The room is well lighted by the large windows at either end and a monitor in the centre of the roof which extends the whole length of the room.

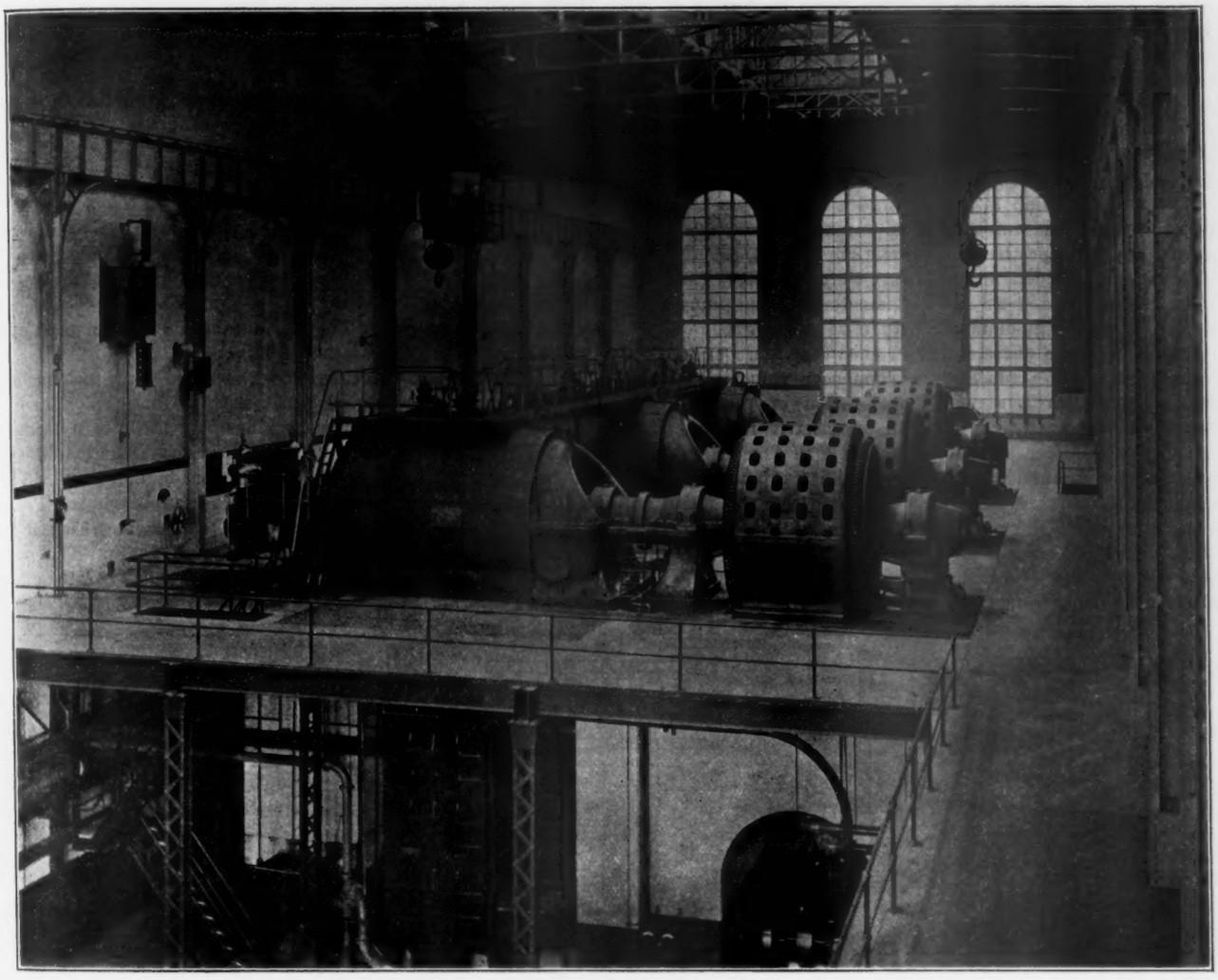
The floor is 23 ft. above the basement floor and each unit rests on a concrete foundation built up from the monolithic slab underlying the whole building. These concrete piers have arched openings below in which is placed the auxiliary machinery for each unit. The piping is located in this basement and is convenient for inspection or repairs.

TURBINES.—The turbines are of the single flow type, and develop 5,500 k.w. or about 7,400 h.p. at 175 lbs. steam pressure and 27½ in. vacuum running at 750 r.p.m. The series of blades, the size of which gradually increase from the high pressure toward the low pressure end, are for mechanical convenience divided into three stages and the longitudinal thrust on each of these groups is counterbalanced by a disc of suitable size, which is under a pressure corresponding to the average pressure of the steam against that set of blades. Longitudinal thrust along the shaft is thus entirely eliminated. The smaller blades are made from special bronze and the larger ones from steel and all were originally roiled in a bar of the required cross sections. They are sawed into proper lengths, set in groups in the drum and the cylinder shell and caulked permanently into position. The cylinder casing is made in halves and split horizontally so that the upper part can be lifted off for inspection of the interior.

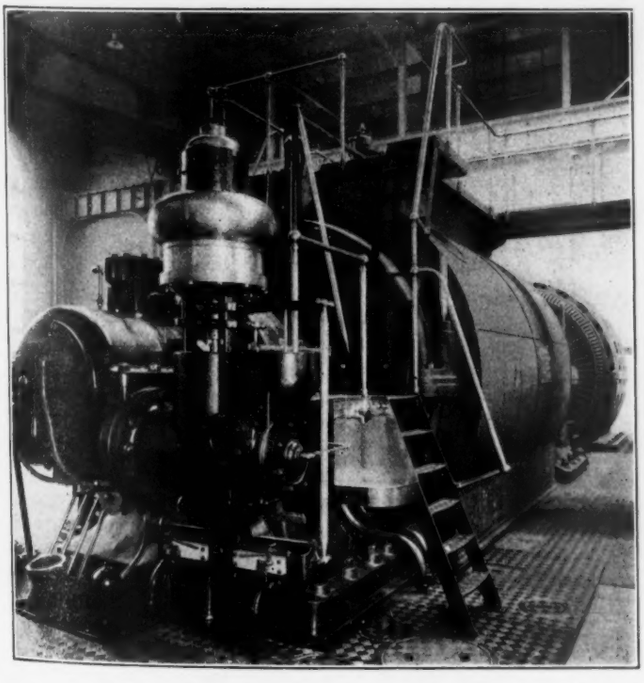
The bearings are supplied with a forced circulation of oil and are also water jacketed. At each end of the cylinder where the shaft passes through, a water seal gland is provided for preventing the leakage of steam along the shaft.

The entire structure of the turbine and generator is carried on a heavy rectangular bed plate, which simply rests upon the foundation but is not fastened to it with anchor bolts. The complete unit is 47 ft. long, 13 ft. wide and 14 ft. high to the top of the gallery railing.

GOVERNOR.—The necessity for maintaining a very small variation in speeds on alternating current units connected in parallel is easily recognized, hence the governor which controls the speed of the turbine has been given the closest attention and study and is of particular interest. It consists of a train of levers deriving its motion from worm gearing on the main shaft of the turbine, which actuates an oscillating pilot valve, which in turn actuates the main admission valve of the poppet type by varying the steam pressure against the piston that lifts it. Steam therefore enters the turbine through this main valve in puffs, the duration of



GENERAL VIEW OF ENGINE ROOM.



VIEW OF TURBINE END OF GENERATING UNIT.

which is controlled by the amplitude of vibration of the little pilot valve. The duration of the vibration of this pilot valve is controlled by a system of levers fulcrumed upon the governor spindle. Directly under the governor there is suspended a rocker carrying a weight which can be moved along it from one end to the other by a screw forming the extended shaft of a small motor carried on the rocker. This rocker is continually oscillating, receiving its motion from a vertical rod attached to the outer end of the governor lever system. The inertia of the whole system is altered and its vibration consequently changed by changing the position of the weight on this rocker through the operation of the motor. This motor is controlled by a switch in the operating gallery, so that the switchboard attendant, whose duty it is to throw the machines into parallel, can control the speed of the machine in order to obtain synchronism.

The turbine is also fitted with an automatic safety stop arrangement which cuts off the steam supply automatically in case the speed exceeds the limit. Convenient to each turbine there is also a bracket in the boiler room wall carrying a stop valve by means of which the steam to the units can be cut off in the boiler room without leaving the engine room.

CONDENSERS.—A separate condenser is provided for each turbine and is located in an arch opening in the turbine foundation. Each has 20,000 sq. ft. of cooling surface consisting of 1 in. seamless brass tubes. The exhaust steam enters the condenser at the bottom and the water of condensation is collected from the bottom by the hot well pump. A large dry air pump exhausts the vapor from the top of the condenser and maintains the vacuum. The circulating water enters the tubes at the top, makes three passes and is discharged from the bottom into the overflow flume.

The condensing water is circulated by a 24 in. double suction centrifugal pump driven by a Westinghouse compound

engine direct connected to it. This pump is capable of forcing 20,000 gallons of salt water per minute against a head of 20 ft. The engines develop 175 h.p. noncondensing.

The condensed steam is discharged to the hot well tanks in the boiler room basement by a 4-in. centrifugal pump, direct connected to a 15 h.p. 220 volt direct current motor. A by-pass arrangement is provided for discharging the condensed steam directly into the flume if desired.

The dry air pump is a horizontal steam driven two stage pump with Corliss valves and an automatic governor on the steam end and positive valve motion on the vacuum end. The vacuum cylinders and heads are water jacketed. The steam cylinders are 10 and 24 ins. in diameter and the pump cylinders are 24 ins. in diameter with a 24 in. stroke.

It has been the universal experience that more or less galvanic action takes place in a condenser using salt water, which results in a serious deterioration of the condenser tubes. This is especially true in an electric railway power house and in order to prevent it a unique scheme has been incorporated in this installation. A sufficient number of volt meter readings were taken between the river, the flume and various parts of the piping to indicate what the differences in potential and its polarity were and it was found that there was a possibility of considerable trouble coming from stray electric currents from the street railway systems of the city entering the plant through the water mains and grounding into the river.

To prevent these troubles an insulated joint was placed in each section of piping entering the power house and a circuit provided from the outside piping directly to the flume. In order to neutralize the effect of such current as might leak past the insulated joints a small booster generator is provided, the positive pole of which is connected to the shunt cable just mentioned and the negative pole to seven different points on each condenser. An adjustable rheostat is provided in each of these branches. A differential volt meter is so arranged that it can be plugged into each of these sections and thus the rheostat in that section is adjusted so that a sufficient amount of pressure is on that branch to neutralize the stray currents and keep the potential in the condenser at zero at all times.

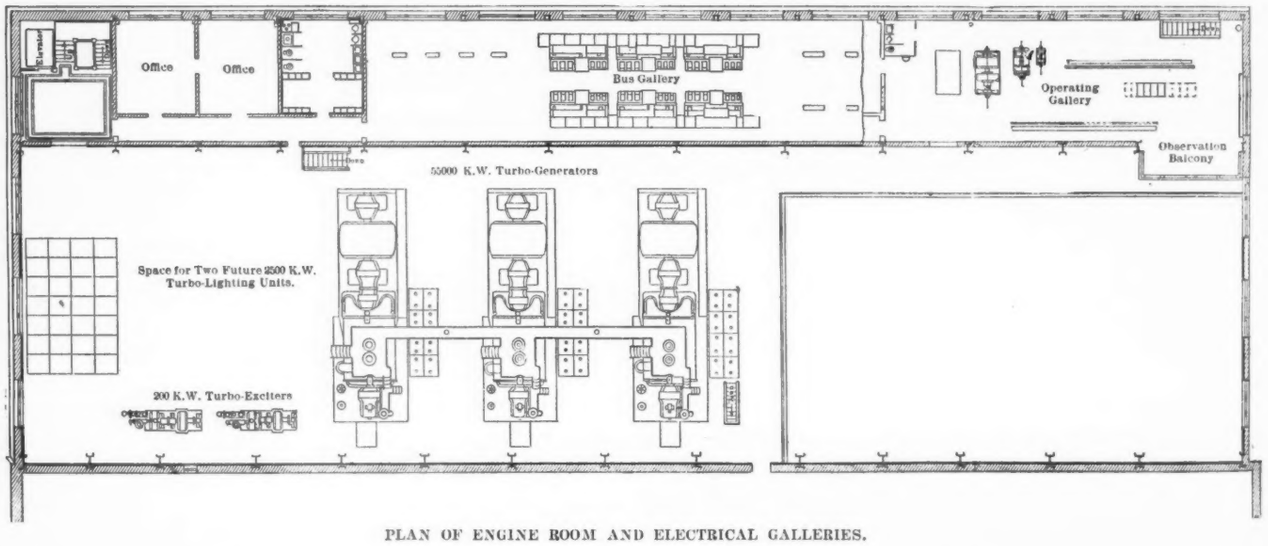
Exhaust Piping.—The exhaust connection between the turbine and condenser is of a square section heavily ribbed cast iron pipe in which is placed a copper expansion joint to prevent strains due to difference in temperature. There is also a provision for open air exhaust through a large 36 in. pipe extending up through the roof and capped with an exhaust header, which becomes operative through a horizontal relief valve operated from the engine room floor.

The dry air vacuum pumps all connect to an 8 in. header above the pumps to which is taken two 6 in. connections from each condenser. This permits any pump or number of pumps to be worked on any condenser. The discharge from these pumps is carried into a common header, which connects to the out board exhaust line.

Exhaust from the other auxiliary machinery is divided into two systems, one receiving the exhaust from the single acting engines which drive the condenser circulating pumps and the other receiving exhaust from all other auxiliary apparatus. The first system leads to the closed feed water heaters and also has a cross connection to the second system which leads to the large open heater previously mentioned.

For returning the water of condensation in the steam pipes to the boilers two Holley gravity return systems are provided. One serving the main or superheated steam pipe and the other the auxiliary steam piping.

Lubricating Oil Circulation.—There are three systems for distributing lubricating oil. The first is that which distributes the oil to the turbine bearings and includes a storage tank 8 ft. in diameter by 14 ft. 8 ins. deep situated in the boiler house at about the level of the coal bunker room. The oil is distributed by gravity to the turbine bearings. From the bearings it is carried to a filter tank from which it is automatically pumped to the storage tank again. The connections of this system are all of brass pipe. The oil pumping and filtering machinery is located in a two story closed

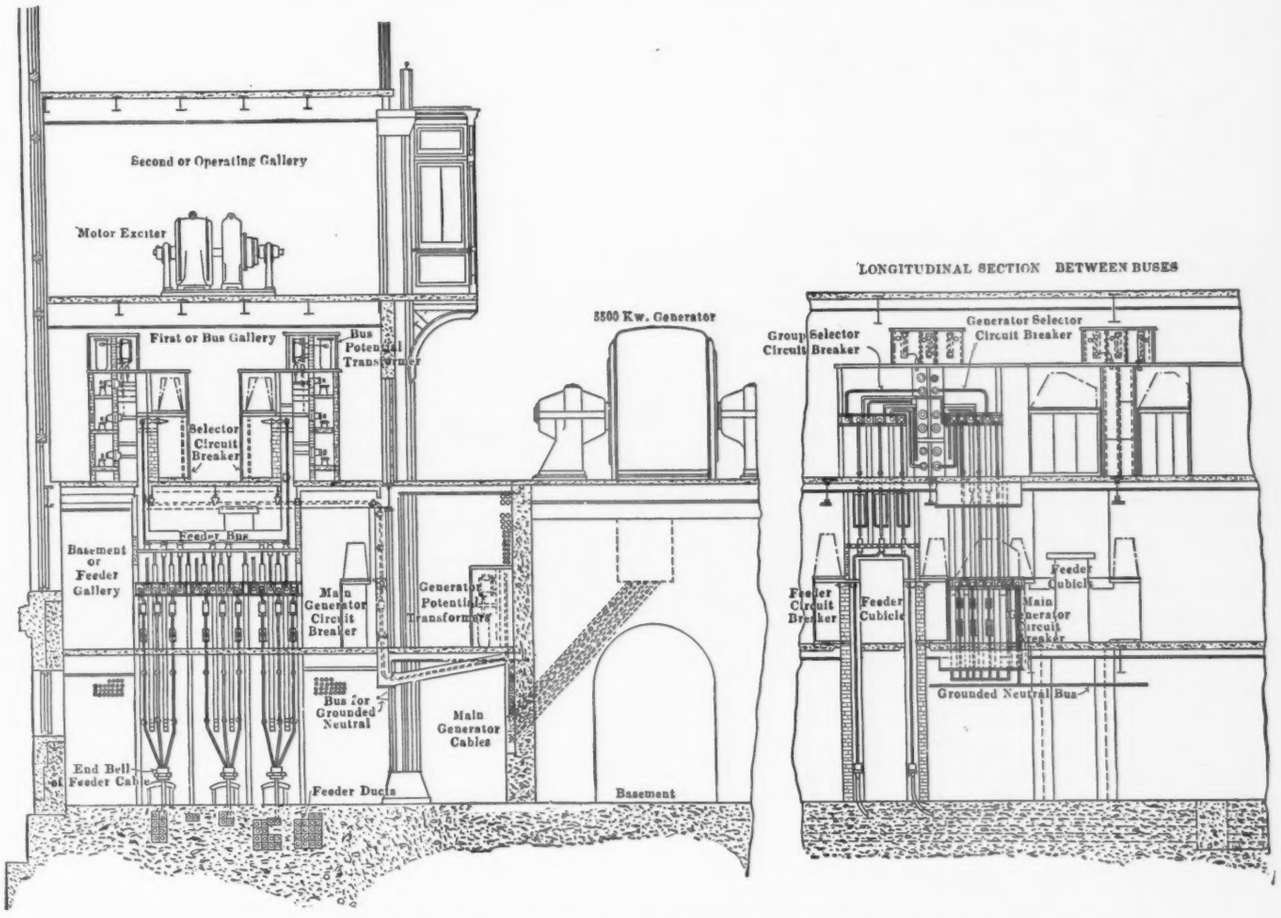



PLAN OF ENGINE ROOM AND ELECTRICAL GALLERIES.

chamber at the east end of the engine room basement. There are about 5,000 gallons of oil in this system and about 90 gals. per min. is circulated through each turbine when in operation. A similar system is used for oiling the crank cases of the Westinghouse engine. Cylinder oil for the lubrication of the cylinders of reciprocating engines is also handled by a similar gravity system, the tank for which is kept filled with fresh oil by means of compressed air.

ELECTRICAL DIVISION.

Generators.—The electrical generators are four-pole revolving field machines of standard Westinghouse construction for turbine drive. They are three-phase alternators, running at 750 r.p.m. delivering current at 11,000 volts and are guaranteed to deliver 289 emperes per terminal. They are star wound with the neutral point of the three machines connected to a common bus, which is permanently grounded through resistance. The stationary armature, enclosed in a large cylindrical yoke of cast iron, consists of a core built up of overlapping punchings of soft steel sheet with the interior surface slotted to receive the winding. Suitable ventilating strips are inserted to form passages for free circulation of air. The coils are wound with copper wire and secured in the slots by retaining wedges of hard fibre. The revolving field is formed out of solid steel discs milled to receive the winding. It is 6 ft. 8¼ ins. in diameter and about 6 ft. long. The field coils are wound with heavy copper straps embedded in




SECTIONS OF ELECTRICAL GALLERIES.—P. N. Y. & L. I. R. R. POWER STATION.

the slots and retained by heavy bronze wedges. Ventilating ducts are provided enabling the revolving field to draw a large supply of air through its interior for the purpose of cooling.

The core is pressed on and keyed to a shaft of nickel steel 19¾ ins. in diameter, through the bearings of which there is a forced circulation of oil. The field is separately excited at 220 volts, current being delivered to the winding through two ring collectors by means of carbon brushes.

EXCITERS.—Three separate sources are provided for exciting the fields, consisting of two steam-driven exciters, one motor-driven exciter and a storage battery. These all give direct current at from 180 to 220 volts.

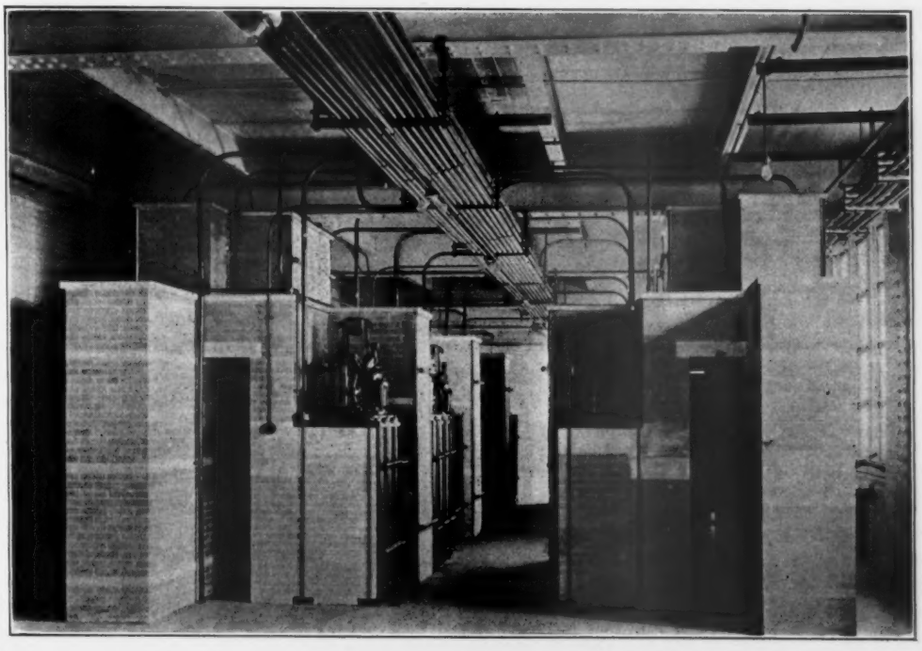
The steam-driven units consist of turbine sets of a design similar to the main units, running at 1,800 r.p.m. These turbines take steam from either the superheated or saturated steam line and can be exhausted through any of the exhaust systems. The generators are 200 k.w. direct connected machines.

The motor-driven exciter is also a 200 k.w. generator and is driven by a 290 h.p. three-phase 440 volt induction motor. This machine is located in the operating gallery and the motor obtains its current through three 175 k.w. self-cooling transformers located in the basement.

The storage battery is located in the engine room basement and consists of 110 cells, each containing seven plates of the type R chloride accumulators manufactured by the Electric Storage Battery Mfg. Company. The tanks are large enough to ultimately contain 11 plates each. This battery has a charge rate of 366 amperes for one hour and is normally kept floating across the excitation buses. A 12½ k.w. booster driven by a 15 h. p. induction motor is installed to charge the battery if necessary.

ELECTRIC CIRCUITS.—The diagrams of the high and low ten-

*(Continued on page 194.)*



VIEW IN BUS GALLERY, SHOWING SELECTOR SWITCHES.

(Established 1832).

# AMERICAN ENGINEER AND RAILROAD JOURNAL.

PUBLISHED MONTHLY

BY

R. M. VAN ARSDALE.

J. S. BONSALL,
Business Manager.

140 NASSAU STREET, NEW YORK.

R. V. WRIGHT, } Editors.
E. A. AVERILL, }

MAY, 1906.

**Subscription.**—$2.00 *a year for the United States and Canada;* $2.50 *a year to Foreign Countries embraced in the Universal Postal Union. Remit by Express Money Order, Draft or Post Office Order. Subscription for this paper will be received and copies kept for sale by the*

*Post Office News Co., 217 Dearborn St., Chicago, Ill.*
*Damrell & Upham, 283 Washington St., Boston, Mass.*
*Philip Roeder, 307 North Fourth St., St. Louis, Mo.*
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One of the possible advantages of the use of superheating which appeals with special force to the American motive power official is the opportunity to use lower boiler pressure and still obtain equal tractive effort. This was mentioned by Mr. Vaughan in his paper on the subject before the New York Railroad Club as well as before the Master Mechanics Convention last year, when it was stated that while such construction was quite usual in Germany, so far it had not been tried in this country. In view of the largely increased boiler troubles with the increase of pressures from 180 lbs. to 200 or 210 lbs., the idea of being able to return to the lower pressure without loss of efficiency is attractive and makes fully as good an argument for the use of superheaters as a considerable saving of fuel or water does. With a view of determining the facts in this connection the Canadian Pacific Railway, which has had much more experience with superheaters than any other American railway, in building a number of consolidation locomotives at its Angus shops is constructing part of them with 21x28 in. cylinders and 200 lbs. of steam, without superheaters, and part with 22½x28 in. cylinders and 175 lbs. of steam, using the C. P. R. type of superheater.

In an address, before the Traffic Club of Pittsburg, on the subject of ways and means of maintaining a car supply, Mr. L. C. Bihler, the president, stated that "The signs of the time point to a universal gondola as the car of the future." This remark, of course, applies to traffic which may be moved in open cars, and the term "universal gondola" is applied to one with drop doors and also with drop end gates, so that when necessary long material may be loaded in them. The drop end weakens the car, and while it may doubtless be used to very good advantage in some districts, it is doubtful if it will ever be very generally adopted. The hopper bottom gondola car with fixed ends seems to have become a very popular type, especially in the Pittsburg and similar districts where a great deal of coal and iron ore are handled.. A number of designs have recently appeared in which this type of car is equipped with drop doors, which, when closed, are flush with the floor. Some of these designs also have provision for discharging almost the entire load by gravity, and unquestionably this type of car, which can be used for almost any commodity which may be moved in open cars, will be a very popular one and will probably come into more general use than the car with drop end gates.

How can a foreman be expected to greatly improve the efficiency of the shop if he is not thoroughly acquainted with the value of the material he is using, as well as the cost of doing the work. To intelligently decide as to the wisdom of repairing or scrapping an article, or as to the choice of material for a certain purpose, he must be familiar with the cost of material, and yet on how many roads do we find the foremen unfamiliar with the costs of material and often making expensive mistakes, which they would not do if they were better posted. Can you imagine this state of affairs existing in an up-to-date manufacturing establishment? Several of the more progressive railroad shop managements appreciate the importance of this question, and on one large system the cost of each article is marked on the bin or convenient to the place in which it is kept in the storehouse, and the storekeeper marks the price of each article on a duplicate of the order slip, which is returned with the material. If there is any question in the mind of the foreman as to the choice of material, and often either one of two materials varying widely in price will give equal satisfaction, or if he is in doubt as to the wisdom of repairing or scrapping an article, he can readily get complete information as to costs. It may cost something to keep such a system in operation, but the saving to be effected undoubtedly warrants its use.

In this issue is shown the large power house recently finished by the Pennsylvania, New York & Long Island Railroad Company at Long Island City. This is one of five large power

plants which within the next few years will furnish electric current to handle every passenger train at present drawn by steam locomotives on the island of Manhattan, in addition to many new trains which will enter by the several tunnels now in course of construction. It is one of two large plants which will furnish power to the trains of the Pennsylvania Railroad Company running in the tunnels from Jersey City under New York to Long Island City, the other to be located in Jersey City; and it will also ultimately move all the trains in the suburban zone of the Long Island Railroad, part of which are at present running by electricity, obtaining current from this plant. In fact, the completion of this power house in advance of the remainder of the work on the Pennsylvania's extension was for the purpose of supplying the requirements of the Long Island Railroad Company. The extensive electrification plans of the three large railroad companies entering New York City which, with the attending terminal improvements, it has been stated, will cost more than the building of the Panama Canal, are familiar to most railroad men, and the completion of this, the first finished section of the work, is of especial interest. Practically all other parts are well under way, the two power plants and several sub-stations of the New York Central are approaching completion, the plant of the New York, New Haven & Hartford is well started, and the work on the tunnels and terminals of the Pennsylvania, as well as the line and new terminal of the New York Central, is progressing nicely.

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In the April issue we presented a new design of locomotive boiler which, as a correspondent whose communication is given in this issue draws attention to, is practically the incorporation of the main features of the successful Yarrow type of marine boiler into a locomotive firebox while still retaining the general arrangement of the present fire-box. As pointed out in the communication, many of the objectionable features of the Yarrow design have been eliminated and new arrangements included which should tend to make it a better steam generator than a marine boiler of the same size.

It is pretty generally believed that a square foot of firebox heating surface is at least five times as valuable for evaporating purposes as the same average area in the flues, in which case the addition of over 500 sq. ft. in the very hottest part of the firebox will result in a large increase in the capacity of the boiler. However, the value of heating surface depends very largely on the rate of the passage of water over it, and if proper provision is not made to get the water to and from all points, its value decreases very rapidly. This feature has been clearly recognized by Mr. Riegel, and an arrangement is made which will not only provide sufficient circulation through the tubes, but will improve the movement across a greater part of the side sheets. It is evident from an inspection of the drawings of this boiler that the flow will be from the top of the baffle plate placed 30 ins. ahead of the flue sheet, downward and backward over the side sheets, up the back head and through the water tubes. This gives a direct circuit which will have but little interference from eddy currents, except on the upper part of the side sheets where there is room for the passage of two currents. Thus with a larger amount of heating surface located to the best advantage and provision made for free circulation, it would appear as if a boiler of this design would give the much desired increase of boiler capacity without any great addition of weight or clearance.

## PROMOTION IN RAILROAD SERVICE.

While it may be necessary to occasionally inject "new blood" into a high official position on a railroad it ought, theoretically at least, never to be necessary to go outside of the service to fill any subordinate position, and the day is likely to come when railroads will adopt the policy of advancing their own men and put a stop to this too prevalent system of going outside of their own personnel for department heads and department subordinate officials. On some roads the policy of advancement of employees has already become law, and it is hardly necessary to say that such roads retain their men and lose very few even of the best of them. This question of advancement of subordinates reaches the fundamentals of organization and to carry out such a plan properly requires improved methods of recruiting and methods of keeping track of the good men, which will lead to the discovery of ability. A scheme of advancement from the ranks necessarily includes a good system of apprenticeship, and places a premium upon the finding of ability among the "men" to be foremen and other officials of the grade of foremen.

For most railroads it would be a hopeless task to inaugurate progressive promotion not because of the lack of material for promotion, but because of the lack of a system which makes it possible for ability to discover itself. As long as the railroads look to the colleges for material for officers the case is hopeless. It is not that good officers are not made from college men and no disparagement to the college men is intended or implied, but it is necessary that a premium should be placed upon coming up through the ranks, whether the material for promotion is the college man or not. Some one has said, "Any fool may go through college, but it takes a man to come up through the ranks." The ideal way to secure the necessary educated man is to educate the rank and file, and by a careful, systematic sifting, educate a few with a view of becoming officers after they make good.

The responsibilities of the present railroad officer requires a knowledge and ability which are generally the result of long experience, and the railroads cannot look for the supply of officers from any school except that of experience. A thorough knowledge of details is the primary requisite upon which to build with experience and education. It is clear that the railroads must look to their ranks for officers both high and low if the standard of railway service is to be lifted to its proper height.

To meet the emergencies of the future it is necessary to provide a surplus of competent employees and subordinate officials equal to any possible demand, and, this may be done through recruiting and apprenticeship, whether it be in the office, in the shop, or elsewhere. To secure such a body of men as material for future promotion, ambition must be cultivated, accompanied by a surety of advancement as a result of long continued conscientious effort. This feeling of ambition can be completely killed by turning too often to men outside the service when important positions are to be filled.

In the army outsiders are not taken in to fill vacant positions and to suggest such a possibility in military matters seems absurd. To obtain good men it is necessary that the service should be attractive and this cannot be accomplished if ambition is not stimulated. Something besides mere permanence of employment is needed. A surety of something better in the future is an absolute necessity. Bright and intelligent young men will turn away from railroad service unless they can see advancement held out as a reward. The keynote for the right sort of an organization is encouragement, and he who complains that of his thousands of employees there is not one capable of promotion to fill any possible vacancy only reveals his incompetence. It is not possible for every one to be promoted, but an officer who disregards his own staff and rank and file and offers an attractive position to an outsider loses an opportunity to promote that loyalty and voluntary endeavor among his subordinates, which are necessary to his own success, and which cannot safely be violated. Promotion always reveals some soreheads, but it is better to have a few of these rather than to deaden the whole mass of employees.

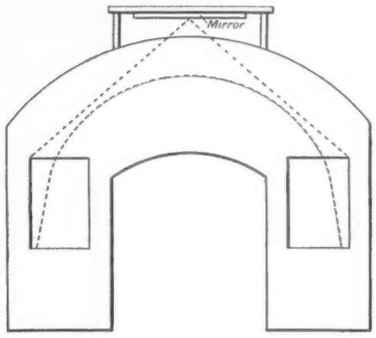
Progress in a large organization is necessarily slow, and it is better that it should be slow as slow growth is most likely to be permanent. Railroads which are to stand in the lead in the long run are those upon which this principle of promotion within the service is appreciated and is made a part of the written and unwritten law.

# COMMUNICATIONS.

## SAFETY DEVICE IN ENGINE CAB.

*To the Editor:*

Having read recently of several wrecks on our railroads caused by the engineer being hurt or killed while on the engine, without the knowledge of the fireman, I enclose herewith a sketch of a




device, whereby the fireman and engineer can see each other, while on opposite sides of the cab.

As shown, a mirror is placed in the roof of the cab, enabling the men to see over the boiler head, even when same nearly touches the roof. A polished steel plate would serve the purpose equally well.

HUGH G. BOUTELL.

## CONVENIENT METHOD OF VALVE SETTING.

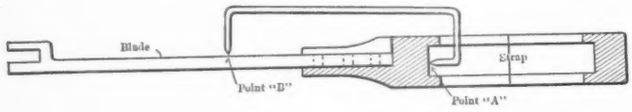
*To the Editor:*

In reading the article in your March number AMERICAN ENGINEER, page, 116, entitled "A convenient method of valve setting," I find that the writer has omitted a very important point, and that is that the prick punch mark on eccentric strap must have a standard and positive location. There is a criticism of this method. In case the strap gets broken and the flanges are broken you lose your point and it is impossible to adjust your blade on a new strap without running the valve over. For several years I have used a "Hook" tram for this work and it overcomes the above. The tram is constructed with a hook on one end and the ordinary square bend on the other end. When it is desired to change a blade from one strap to another, place the hook end inside the strap on the wearing surface, and scribe a line on the blade before loosening any bolts. When blade is fastened to new strap set it so that tram point comes on the mark, and you have the correct length of blades as you have the positive length from wearing surface of strap.

Your truly,

New Haven, Conn. A. L. ROBERTS.

*To the Editor:*—In the March issue of your journal I noticed an article entitled "Convenient Method of Valve Setting." This method would be satisfactory only in case the wearing surface of the eccentric strap never changed or the blades had never been altered in the roundhouse previous to the breaking of the strap. Now, it is very evident, the former changes in proportion to the length of time the engine has run and very frequently the blades




are altered. In my experience I have found that an engine is not out of the back shop long before the roundhouse men find it necessary to make some changes in the blades to keep the engine square. The valves might have been perfectly square when leaving the shop, but after being broken in and running a few trips would show out.

In my roundhouse experience I have had a good many broken straps to change, and the best tram I have ever seen, for the purpose of setting the blade at the right length, is the one shown in the sketch I enclose. The old strap and blade are taken down together and point "A" of the tram placed on the wearing surface of the strap about in line with the centre of the blade; with point "B" scribe a point on the blade. Disconnect the blade from the broken strap and substitute the new one. Place point "A" of the tram on the wearing surface of the new strap in line with the centre of the blade and move the blade until point "B" coincides with the mark made by the tram before. Secure the blade in that position and you can be sure it is exactly the same length as before. I have never had a strap to change yet where I could not use this tram. It does not need to be a standard length, as any convenient length will answer the purpose. F. A. DAILEY.

Sedalia, Mo.

## RIEGEL WATER TUBE BOILER.

*To the Editor:*

Referring to the Riegel design of locomotive boiler shown on page 136 in your April issue, it seems to me that the main idea admirably provides exactly what we have been requiring with the wide firebox, and that any adverse criticism would be more justly directed to an indisposition to at least make trial of it than to design itself. Aside from the simple and practical manner in which the necessary additional firebox heating surface is supplied, I am considerably impressed with the idea of converting the sides of the mud ring into easily opened mud drums. This also enables the rapid interior incrustation of the water tubes to be easily taken care of by ordinary turbine cleaners. Also, these tubes will apparently provide that increased rapidity of circulation, whose lack in the present designs is so much deplored. In this connection, however, I am impelled to oppose the designer's idea of placing a circulation baffling sheet in ahead of the tube sheet, in fact, I believe such an obstacle would ruin the boiler. In view of the large amount of water which would have to flow to the water pockets it would seem as if a wider throat would be desirable. It also occurs to me that the disturbance of the wagon-top surface could be avoided, while, yet providing the necessary support to both the wagon-top and the staying cylinder. The brick arch seems a little awkward—in line with recent Northern Pacific experience, possibly the addition of a combustion chamber would enable a nicer arch arrangement.

As stated, however, these objections are minor details, which could be left to individual preferences, the main idea is the thing and it looks to the writer as if Mr. Riegel has hit what we have been looking for.

WESTERN.

*To the Editor:*

My experience with Yarrow type water-tube boilers in marine service and locomotive type boilers in railroad service, indicates that the design of water-tube locomotive boiler shown in your April issue has the good features and lacks many of the bad features of both types. The water-tube portion is precisely the idea of the Yarrow type.

This type of boiler for marine service is usually made with 1-in. tubes placed in five ranks and very close together, their heating surface being far greater than normal conditions require. This is necessary because the only way to remove an inside failed tube is to cut out and plug good tubes till the split one is reached, working from the grate side. Most water-tube boilers are subject to this destruction of heating surface. The water pocket mud-ring of the Riegel boiler provides access to the lower ends of the tubes, which is an impossibility in regular Yarrow boilers, and will allow tubes to be tightened or replaced instead of plugged. The staying ribs in the mud-ring need to be mostly holes, to allow for a very high circulation of water to supply the tubes and prevent burning them.

Much trouble is given by soot and clinkers forming among the close Yarrow tubes. This is so great that a steam jet blown every watch, and a crooked saw to cut clinkers out at every shutdown are necessary to keep the boiler in service, these troubles will be avoided by the large tubes and wider spacing in the Riegel boiler. The advantage of the original idea of the Yarrow type, i. e., a straight tube, is herein well exemplified.

The staying cylinder placed above the crown sheet should act as a good baffle, keeping water well away from the main current of steam which will pass from the tubes to the dome. There is a possibility, however, that it will act as a pipe conveyer, and carry all the water onward with the steam. Yarrow boilers usually

prime badly at lower power, and give no trouble when forced hard. The brick arch ought to be a wall at the front of the water-tubes, forcing most of the gases among them. The method of supporting the inclined form of arch shown in the illustration is not clear.

I have only condemnation for the cold water dam, placed ahead of the flue sheet. The lower flues will be continually chilled and leak incessantly. Better put the water supply in such a way as to help the circulation, not hinder it. With that removed the circulation in this boiler should prove to be much better than any other locomotive boiler I have ever seen designed. Expansion should cause little or no trouble, for the construction is very simple and very accessible.

I hope we shall see a boiler of this type tried, for it appears to be a long step forward, and in a direction where improvement is much needed

PAUL R. BROOKS.

New York.

## GENERAL FOREMEN'S CONVENTION.

*To the Editor:*

A study of the program of the International Railway General Foremen's Association convention (see page 196 of this issue), to be held at St. Louis the early part of May, suggests that the value of the association could possibly be very greatly increased if more of the subjects to be considered were more intimately concerned with the work of the foremen. As the association is made up of superintendents of shops, general foremen, division foremen, machine foremen, roundhouse foremen and their assistants, the consideration of such questions as electricity versus steam as a motive power, electricity versus oil for headlights and the pooling of engines seems to be a little out of place, especially when we consider the many serious problems which confront the shop and roundhouse foreman in their efforts to secure greater efficiency and increased output.

The progress which has been made in shop equipment, operation and organization during the past few years, the marked increase in the size and capacity of locomotives and cars, and the fact that the larger locomotives and the changes in the method of operating trains has made it necessary to radically change roundhouse design, operation, organization and equipment would suggest that the time of the convention, which will necessarily be limited, could be much more profitably spent in discussing subjects concerned with these features rather than subjects which come outside the jurisdiction of the foremen, and properly come within the scope of other organizations.

There is hardly a more important question before the railroad mechanical departments to-day than that of shop organization and operation. Magnificent and extensive shops have been built and equipped with the latest design of machinery, and, when placed in operation have made a comparatively poor showing, and, then came the realization that the larger plant required a different and more perfect kind of organization than the older and smaller ones. The master mechanic who has under his jurisdiction a large shop in connection with his work over a division of 150 miles or so, is fast disappearing, and in his place we find a shop superintendent who devotes his entire time to the shop and reports directly to the head of the motive power department, and a master mechanic who looks after the division and has nothing to do with the shop. It is surprising that some phase of this problem of organization does not find a place on the program.

Then there are the all important subjects of piece work; the individual effort method of profit sharing and the premium plan. The foremen should consider these systems and the method of their introduction. It is all important that he be perfectly familiar with them, for, while in many cases it may not be in his power to decide upon their introduction, yet their success after introduction is largely dependent upon him.

There are many other important questions which might be considered such, for instance, as special jigs, mandrels, tools, etc., to improve the shop production; special tools for roundhouse work, shop schedules, improved methods of handling work, the relation of the shop foremen to the store department, the care of belts, use of high-speed steel, the requirements of various machine tools as regards variable speed, and a hundred others more or less important.

This communication is not intended as a criticism but rather a suggestion. The association can readily make itself exceedingly valuable, and, indeed, is doing remarkably well considering the short time it has been in existence. It should be loyally supported by all those who are eligible to membership

A. FOREMAN.

## IMPROVING RAILROAD SHOP EFFICIENCY.

BY CHARLES COLEMAN.*

Reduction in the cost of repairs without impairing the efficiency of the locomotive will be considered from the shop viewpoint only, and this will, of course, not include outside conditions, which cause excessive repairs, such as bad water, overloading, pooling, double-heading, delay on sidetracks, and, worst of all, the neglect of running repairs.

In order to successfully reduce the cost of repairs it is important that those in charge should be thoroughly familiar with the cost of making the repairs and the cost of material entering into them, and this data, if possible, should be known for each operation. To this end duplicate work should be done on shop orders and costs should be furnished as quickly as possible, so that the output of the machine tools and the cost of manufacture may be closely followed and a check can be kept on the storekeeping department in charging out material. Every facility should be given those interested to obtain information concerning costs. Where the material is manufactured at both the main and the smaller shops, price lists for doing the work at the main shops should be sent out frequently to the other shops for comparison.

Where manufacturing is done at different points on the road it is advisable to specify certain kinds of work which are to be done at each point in order to save the duplicating of expensive machinery and small tools, and also because the manufacture of articles in large quantities makes it possible to give more thought to the making of special tools and jigs and the cost of manufacture can thus be materially decreased. It also makes posssible the use of turret and automatic machinery where their cost would be prohibitive if the same class of work was done in each of the shops and the machines were in use only a small portion of the time. New machinery should never be purchased unless it can be clearly shown that the improved output will more than offset the interest on the capital invested.

The importance of standardizing work and the use of jigs cannot be overestimated. This applies to the boiler shop and other work as well as to the machine shop. There is no reason why holes in the flue, door and side sheets of the firebox should not be made interchangeable as easily as are guides or crossheads. The use of jigs saves time both in the laying out and machining, and in many cases there will be a considerable saving in material. The judicious use of templates and jigs makes possible a saving of one-half the time in laying out in a boiler shop and more accurate results are obtained.

So much has been said concerning rapid production and high-speed steel that little can be added except that it is important that the output of the smaller machines be not neglected while records are being made on the larger tools, such as wheel lathes, milling machines, etc. Much can be gained by improving the chucking and setting facilities, and 15 minutes saved in this way is as valuable as that much time saved in tearing off the material with high-speed tools and it results in less damage to the machinery.

The unnecessary handling of material is often lost sight of and care should be taken in locating new machinery to require a minimum amount of handling of material. It is sometimes good policy to move a machine already placed, in order to do away with unnecessary trucking or handling. A piece of iron cannot even be picked off the floor without adding to its cost.

Co-operation and good feeling between the different foremen is absolutely esssential, and this is also true in regard to the men. All promises should be kept and contracts should be lived up to. As a rule there need be no friction and labor trouble if the men are treated fairly. The old adage "like master like man" still holds good.

Suggestions for the good of the service should be given respectful attention, and if adopted the party making them should at least be given credit. Opportunity should be given

*General Foreman C. & N. W. Ry. shops, Winona, Minn.

the foremen to visit other shops and see what other people are doing.

Co-operation between the mechanical and the storekeeping department and advising with the storekeeper in regard to present and anticipated future needs will result in the saving of money for the company and avoid many vexatious delays. Notice should be given to the shop superintendent or master mechanic of the engines which are expected to come in during the next 60 or 90 days, and as far as possible a memorandum of the new material which will be required. In this way the amount of stock necessary to be carried can be reduced to a minimum. It is also advisable for a capable representative of the mechanical department to go through the stock at intervals with the storekeeper and cut out all obsolete material.

The question of patterns requires close study in order to avoid carrying thousands of dollars worth of extra material in the storehouse and also of having to remove an unreasonable amount of stock in the machines. A certain road with 1,400 engines has five eccentric patterns, while another road with 350 engines has about 25 eccentric patterns.

A good idea in use on one large system is that whenever a tool is gotten out and is a pronounced success, blue prints are sent to headquarters and it is incorporated in a blue print book of special tools and sent to all points on the system.

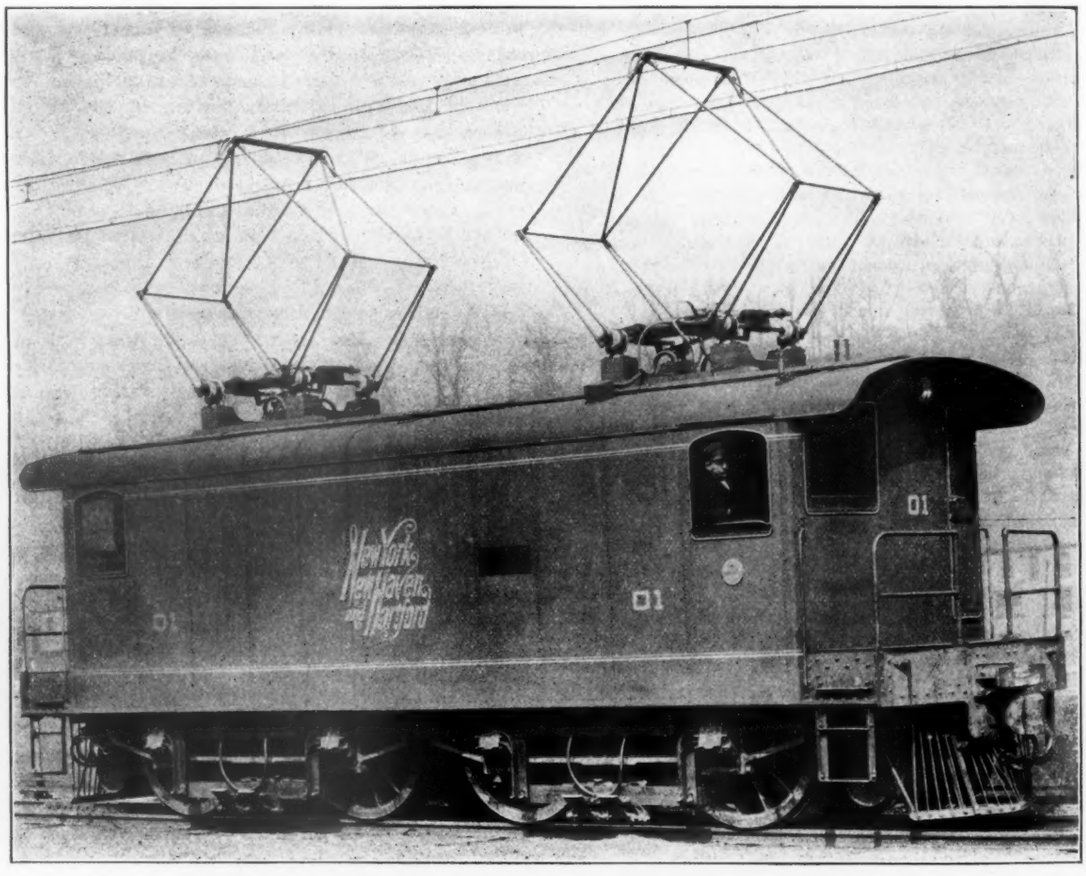
A thorough examination should be made of all engines coming to the shop for repairs, and no engine should be taken into the shop until all necessary material is on hand. In order to reduce the average pit hours per engine to a minimum those in charge should have the necessary authority, sufficient superintendence should be allowed, and the shop force should be properly organized, and, of course, in addition the shop should be fairly equipped for doing the work.

## SINGLE PHASE ELECTRIC LOCOMOTIVE.

NEW YORK, NEW HAVEN & HARTFORD R. R.

The present plans of the New York, New Haven & Hartford Railroad Company contemplate the electrical operation of its main line between New York City and Stamford, Conn., a distance of over 33 miles. That portion of the railroad which lies between the Grand Central Station and Woodlawn, N. Y., utilizes the tracks of the New York Central & Hudson River Railroad, and constitutes a portion of the electrical zone of that company. On this section of about 13 miles the New Haven trains will be operated by the direct current third rail system there installed, but between Woodlawn and Stamford the road will be equipped to use single phase alternating current, and the trains will be operated by electric locomotives which take current from an overhead trolley line.

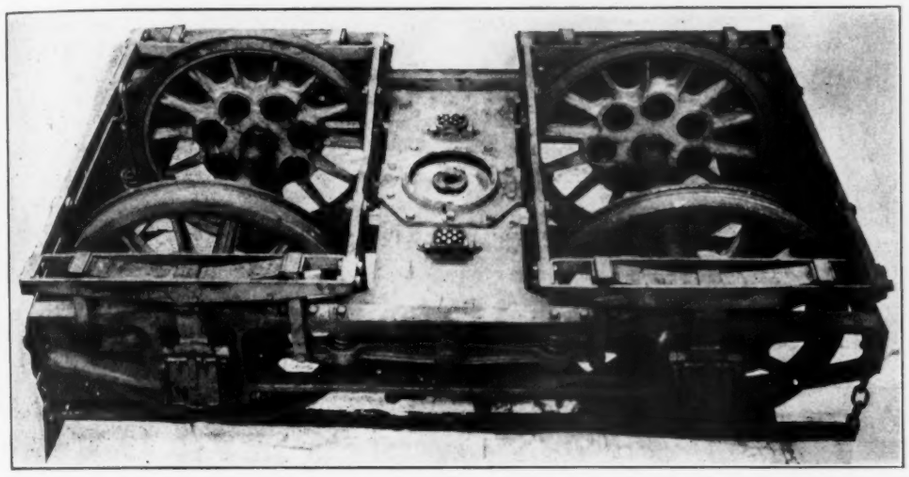
The locomotives for use under these conditions must necessarily be capable of operation both by alternating and direct current, and be equipped with collectors for taking current from a trolley or third rail, either with an under contact, as will be used on the New York Central Lines, or an over contact, as will be used in certain small stretches of the New Haven Railroad. Locomotives fulfilling these requirements and capable of handling a 200-ton train in local service on a schedule speed of 26 miles per hour with stops averaging about two miles apart, or a 250-ton train on through service at a maximum speed of 60 miles per hour, are being built by the Westinghouse Electric & Manufacturing Company. When it is desired to handle heavier trains than mentioned above, two or more locomotives can be connected together and operated as one unit. Each locomotive measures 36 ft. 4 ins. over bumpers, and weighs approximately 85 tons. They are, as can be seen in the illustration, mounted on two trucks, each having four 62-in. driving wheels.




SINGLE PHASE ELECTRIC LOCOMOTIVE.—NEW YORK, NEW HAVEN & HARTFORD R. R.

The frame, trucks and cab of the locomotive were built by the Baldwin Locomotive Company, and the electrical equipment complete by the Westinghouse Company.

FRAMES.—The main frame of the locomotive through which the drawbar pull is transmitted to the trucks is of very strong and stiff construction, being built up of standard section steel members thoroughly braced and reinforced. It is set low in order to get as near a direct pull from the coupler to the truck as possible. The side sills are heavy channels placed outside the wheels, and are rigidly tied together by heavy end sills and transoms, also of channels. The whole structure is braced by the steel floor and heavy gusset plates wherever needed. The pull to the frame is transmitted from the trucks through center pins.



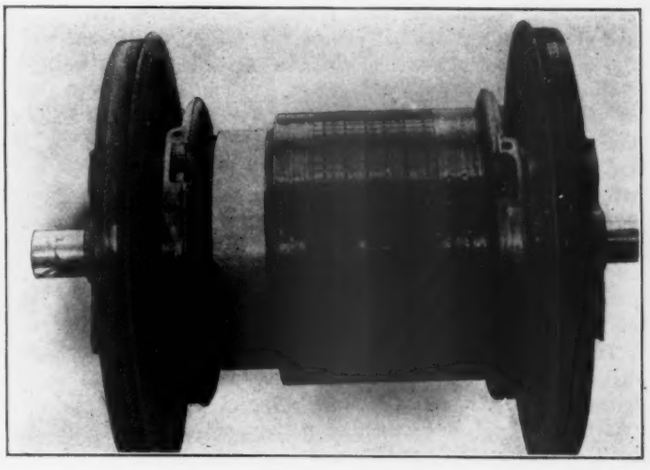
SINGLE PHASE ELECTRIC LOCOMOTIVE.—VIEW OF DRIVING TRUCK, WITH MOTORS REMOVED.

The cab is formed of steel plates mounted on a framework of Z bars, and has windows and doors, as shown in the illustration.

TRUCKS.—Each of the trucks, as above mentioned, is mounted on two pairs of 62-in. driving wheels with outside journals. Side frames of forged steel with pedestals for the journal boxes are placed outside the driving wheels, and connected together at the center by a very heavy pressed steel bolster, which carries the center plate. These bolsters are made wide and deep, and have an extra width of bearing at the side frames, to which they are securely fastened. The ends of the side frames, which extend beyond the wheels, are cross connected by steel plates, thus making a rigid and strong truck frame of simple design. The bolsters are 30 ins. wide at the center plate and nearly 60 ins. wide at the side frames. The pedestals are provided with shoes and wedges, and carry a modified design of M. C. B. journal boxes. The centre plate is 18 ins. in diameter, and special provision is made for lubricating both pin and bearing. The weight is carried from the frame to the wheels by semi-elliptical springs on top of the frame over each journal box, which are equalized together at the inner ends by a cast-steel equalizing bar, which has coil springs at either end to assist in maintaining the equilibrium.

Each truck carries two motors of the compensating gearless type, wound for 235 volts alternating and 275-300 volts direct, which have a nominal rated output of 250 h.p. each, therefore giving the locomotive a total hourly rating of 1,000 h.p., or a continuous operating capacity of 800 h.p. The motors are carried on a quill which surrounds the driving axle, but does not bear upon it. This quill, on which the armature is carried direct and the field through bearings, has $\frac{5}{8}$-in. clearance around the axle, and is connected to each driving wheel by seven pins projecting from the flange of the quill on either end, which fit into corresponding pockets formed in the hub of the wheel. These pins do not fit the pockets in the wheel center, there being a clearance left for the insertion of helical steel springs, which are wound with their turns progressively eccentric. These springs fit between two steel bushings, one of which slips over the pin on the quill and the other fits inside of the pocket in the wheel center. These springs are under compression, both longitudinally and horizontally, so that at all times they fill the pockets in the wheel but permit a lateral motion. By this method all of the power from the motor is transmitted to the wheels through a yielding connection. The weight of the motor is carried on a frame, which passes around the wheels and over the side frames, and rests directly upon the journal box spring bearing, as is clearly shown in the illustration of the truck. Each frame carries four long bolts, which receive the weight of the motor through a heavy coil spring at their lower ends. The torque of the motor is resisted by heavy parallel rods, which anchor the motor frame to the truck above and below the axle, and permit a vertical or side motion of the motor, but prevent excessive strains from coming onto the driving springs. If these springs are compressed more than $\frac{1}{4}$ in. by the heavy centrifugal force exerted by the motors when rounding curves the force is taken up by noses on the motor frame, which fit into corresponding recesses in the cross ties between the side frames of the locomotive.

This method of motor suspension removes all dead weight from the axle and makes all parts of the locomotive, with the exception of the driving wheels, axles and journal boxes, supported by springs. The motors are arranged for ventilation by a forced circulation of air, which enters under pressure, is distributed throughout the motor and escapes through perforated covers. This air is taken from the inside of the cab and forced through conduits in the frame and conducted to openings in the motor casing by flexible connections. This forced ventilation has the advantage of not only keeping the motor cool, but also prevents any dust or dirt collecting on the motor parts, since the circulation is always outward.

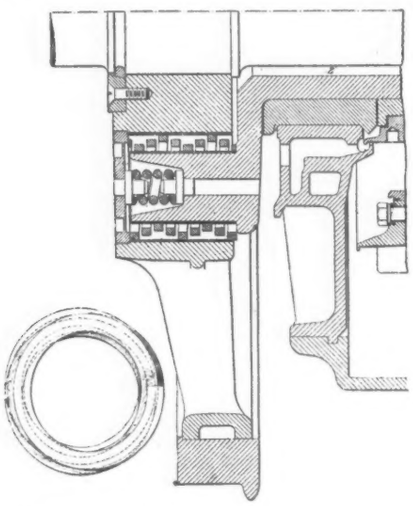


SINGLE PHASE ELECTRIC LOCOMOTIVE.—VIEW OF DRIVER WHEELS, WITH ARMATURE ATTACHED.

CURRENT COLLECTION.—The location of the shoes for collecting current from the third rail shows clearly in the illustration, as does also the pantograph arrangement for collecting the alternating current from the trolley wire. These collectors, of which there are two on each locomotive, are of the bow type, and each has a capacity sufficient to carry the total current required by the locomotive under average conditions.

They are pneumatically operated, and can be raised and lowered by the driver from the inside of the cab.

CONTROL.—The current is brought in from the trolley at 11,000 volts to the auto transformers, the secondary windings of which are tapped at six different points giving six alternating current voltages, or running points. There are also a small number of midway steps, which are used only in passing between working notches on the controller. Thus in operating on the alternating current system no resistance is introduced except a small amount constituting a preventative device to diminish the short circuiting effect when changing from one transformer contact to another. The current is carried through the proper safety devices directly from the controller to the motors, which are connected in parallel. For operating on direct current the motors are connected in the ordinary series parallel manner through resistance. A new feature in this control has been introduced, permitting several efficient running points to be obtained between the point of disconnecting the series connection and going into multiple as it is ordinarily arranged, by the shunting of the fields. This can be done on this type of motor without impairment of commutation.



SECTION SHOWING ARMATURE CONNECTION TO DRIVING WHEEL.

Two auto transformers are placed in each locomotive, which are connected in parallel across the high voltage, but have the low voltage side of each connected to a different pair of motors through a separate control. The main controllers are of the electro pneumatic unit switch type, operated from a master controller at each end of the cab. This system is arranged for multiple unit service, so that two or more locomotives can be coupled and handled by a single driver.

The master controller is of the drum type, and is operated by a horizontal lever, which moves through an arc of about 60 deg., with notches and latch wheel to define the different positions. The reversing is accomplished by a separate handle which interlocks with the main lever.

There is also included in the equipment two air compressors driven by motors, which can be operated on either alternating or direct current, for furnishing air for braking power; two blowers, driven by smaller motors, which furnish the air to the transformers, motors and rheostats, and a steam generator for supplying heat to the railway coaches. Also a complete Westinghouse air brake equipment and signal apparatus, automatic bell ringers, air whistles, sanding apparatus, etc.

Thirty-five of these locomotives are being built, the first one of which has been given a very thorough test under all operating conditions, and has shown itself capable of accelerating a 200-ton train at a rate of one-half mile per hour per second, and has been operated on an unfavorable track at speeds of 60 miles per hour.

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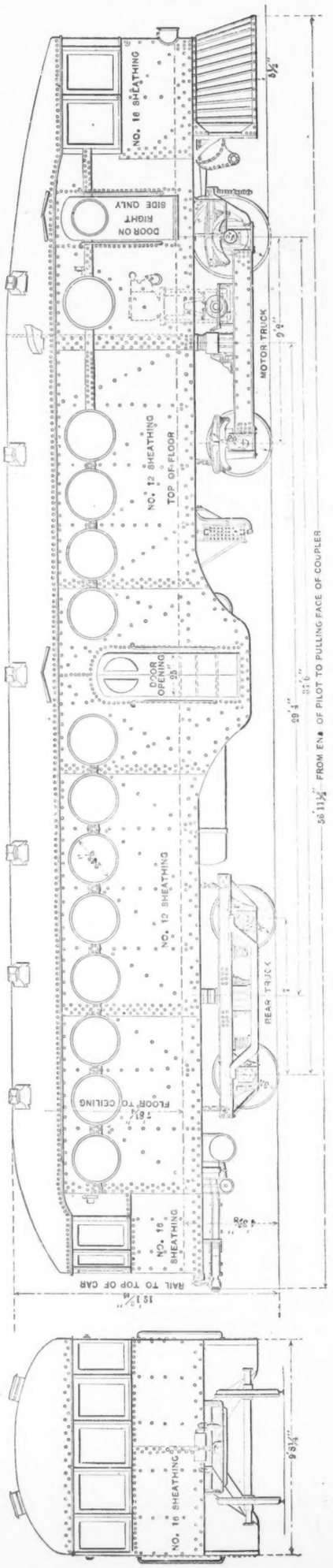
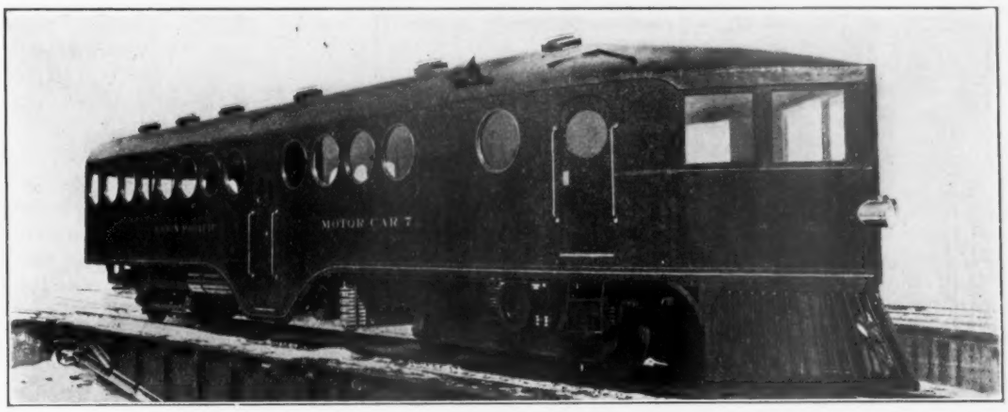
RAILROAD CLUB AIDS SAN FRANCISCO.—At the April meeting of the New York Railroad Club $1,000 was donated from the club treasury for the relief of suffering in San Francisco.




ELEVATIONS OF GASOLINE MOTOR CAR NO. 7.—UNION PACIFIC R. R. CO.



GASOLINE MOTOR CAR NO. 7.—UNION PACIFIC R. R. CO.

## GASOLINE MOTOR CAR NO. 7.

UNION PACIFIC RAILROAD.

Since finishing motor car No. 2, which was illustrated and described in this journal November, 1905, page 420, the Union Pacific Railroad Company has built five more cars on the same general designs, four of which are in regular service.

Motor car No. 2 is at present in service between Kearney and Callaway, Neb., making a round trip of 130 miles daily except Sunday. Car No. 3, which differs from No. 2 only in that it has a baggage compartment, is in service between Houston and Galveston, Texas, on the Southern Pacific lines. Car No. 4, a practical duplicate of No. 3 in general design, is on the lines of the Oregon Railroad & Navigation Company. Car No. 5, which is similar to No. 2, is being operated out of Los Angeles, Cal., and Car No. 6 is being run between Lawrence and Leavenworth, Kan. It draws a trailer, and makes a round trip of 68 miles daily except Sunday.

Motor car No. 7, the latest car to be built, which is illustrated herewith, is of somewhat different design, although in size and weight it is nearly the same as No. 2. The changes consist principally in the use of a side door in the center of the car and of round windows in place of square ones.

The construction of the body to allow the doors to be put in the center of the sides has been very carefully worked out, and has resulted in no loss of strength. The side sills are dropped down below the door sill, and a patented steel framing has been incorporated, which, in connection with slightly heavier steel casing, gives the full strength and stiffness desired. The thicker steel side plates used throughout make this car considerably stronger than its predecessors.

The roof of the previous cars was 15 ins. lower than that of an ordinary passenger coach, and that of No. 7 is still 9 ins. lower, making it 2 ft. below a coach roof. Notwithstanding this lower roof, the ventilation is excellent, being fully equal to the former cars.

The use of the round windows has allowed the elimination of large wooden side posts in this car, which gives an increase of 8 ins. in the interior width. These windows are tight fitting, and are dust and weather proof. They are placed so close together that the interior is extremely well lighted.

Built-up veneered wooden seats are used with a semi-circular seat at the rear. The seating capacity is 75. The interior is finished in English oak.

The motor truck, which carries the 100-h.p., 6-cylinder gasoline engine direct, has a wheel base of 9 ft. 2 ins., and does not have the wheels equalized together as is usual. The engine is set just ahead of the bolster, and connects to the front pair of wheels, which are considerably larger than the rear pair, through a chain from the axle. The engine is built after special railroad patterns, and has a "make and break" spark ignition, with a primary battery to start on and a magneto for regular running service. The cylinders are 8 x 10 ins.; of the upright type, placed at right angles to center line of car. The six cylinders are arranged and connected up in opposed sets of three cylinders, resulting in three power-giving pulsations at each revolution of crankshaft. Compressed air is used for starting the engine, and a synchronizer is used in the changing of speeds.

The car is equipped with direct air brake system, with braking power on all wheels. Attached to the crankshaft is an air pump, which supplies and maintains 100 lbs. air pressure in two reservoirs of 13 cu. ft. each. Numerous tests on Car No. 2 at a speed of 20 miles per hour have shown that the car stops in 112 to 115 ft., without inconvenience to passengers. In addition to the air brake, the car is also equipped with a ratchet lever hand brake.

After running around Omaha yards and vicinity for the purpose of limbering up machinery, etc., motor car No. 7 was given its first long-distance trial April 14th and 15th.

On April 14th it left Omaha as second section of train No. 1, Overland Limited. The motor car gained on No. 1 to such an extent that at Fremont, 46 miles from Omaha, it was held at the block. Owing to a heavy wind and meeting trains from this point on some time was lost on No. 1's schedule. However, the total time of motor car from Omaha to Grand Island was 5 hours 12 minutes, with a delay of 40 minutes account orders, meeting trains, etc., the actual running time for the 153.6 miles being 4 hours 32 minutes, or 34 miles per hour. There was no delay whatever on account of the motor car, and the machinery was in almost constant motion from Omaha to Grand Island.

On return trip April 15th a high-speed run was not attempted, and the car was delayed over 3 hours for orders, meets, etc., in addition to a slight delay on account of a hot bearing. The actual running time for the 153.6 miles was 4 hours 10 minutes, or 36.3 miles per hour. From Elkhorn to South Omaha, a distance of 24.3 miles, the time was 36 minutes, or 42 miles per hour. A maximum speed of 53 miles per hour was attained on this trip.

We are indebted to Mr. W. R. McKeen, Jr., superintendent M., P. & M., to whom credit is principally due for the success attained in the design and operation of all these cars, for the above information and illustrations.

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RAILWAY STOREKEEPERS' ASSOCIATION.—The third annual meeting of the Railway Storekeepers' Association will be held at the Auditorium Hotel, Chicago, May 21, 22 and 23. An interesting program has been provided, and the indications are that the convention will be a very successful one.

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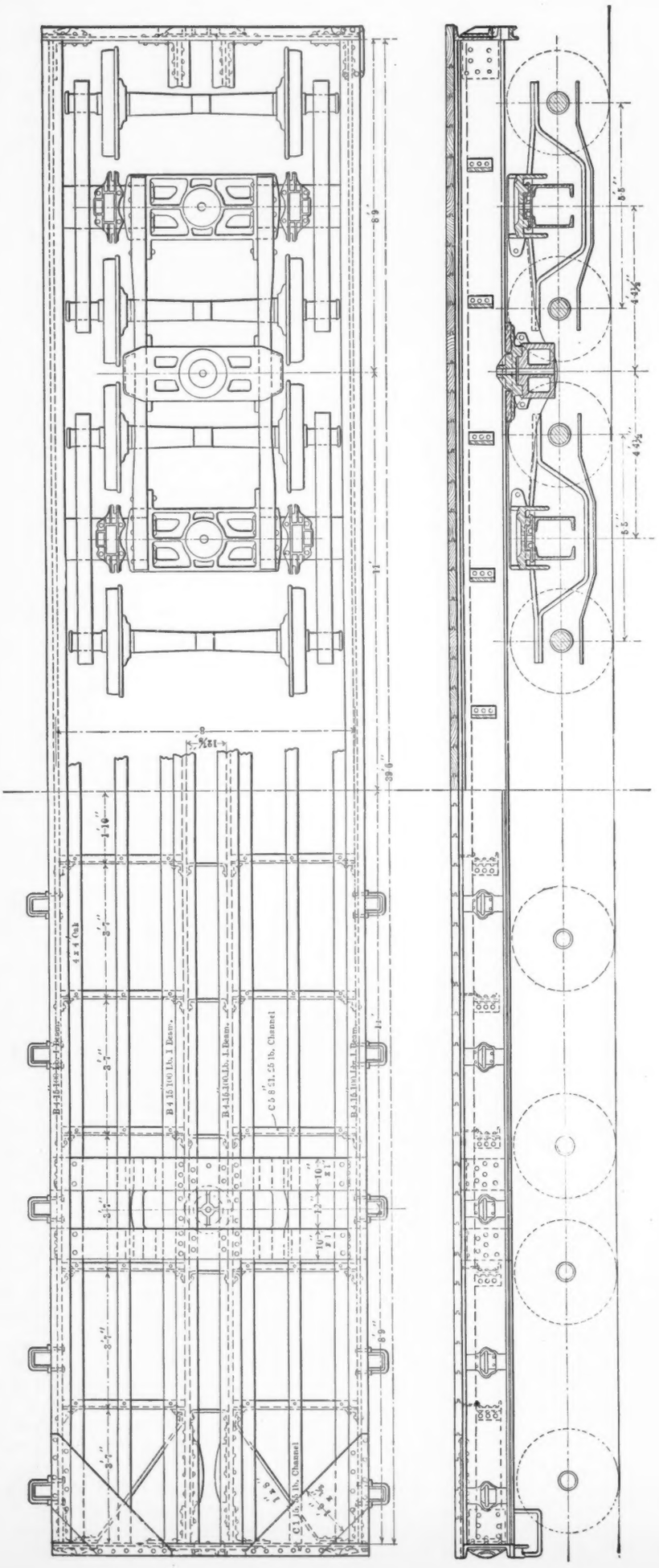
CAPACITY OF THE LOCOMOTIVE.—Formerly the capacity of a locomotive was estimated largely from the capacity of its cylinders, and this led occasionally to the use of cylinders of such dimensions that the boilers provided were not capable of generating sufficient steam to enable them to be worked at their maximum economical power for any length of run. Today this is changed, and the first consideration is the capacity of the boiler.—*Mr. G. J. Churchward, before the Institution of Mechanical Engineers.*



100-TON CAPACITY FLAT CAR.—PLAN AND SIDE ELEVATIONS.

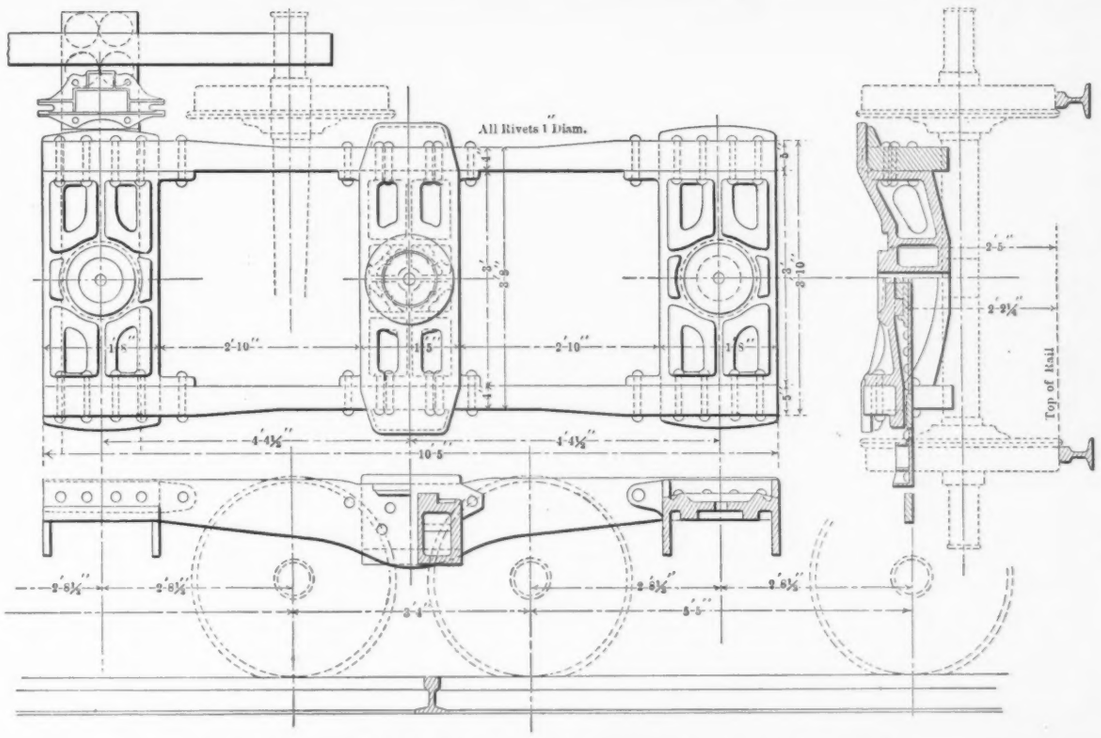
## 200,000 LB. CAPACITY FLAT CAR.

The desire to ship heavy castings and parts of large engines which often individually weigh more than 100,000 lbs. led the Allis-Chalmers Company, of Milwaukee, to request the mechanical department of the Chicago, Milwaukee & St. Paul Railway to design for them some flat cars capable of carrying 220,000 lbs. This work was turned over to Mr. James F. DeVoy, mechanical engineer, who, in connection with Mr. A. E. Manchester, superintendent of motive power, and Mr. J. J. Hennessey, master car builder, has designed the car shown in the illustrations herewith, two of which have been built at the West Milwaukee shops of the road.

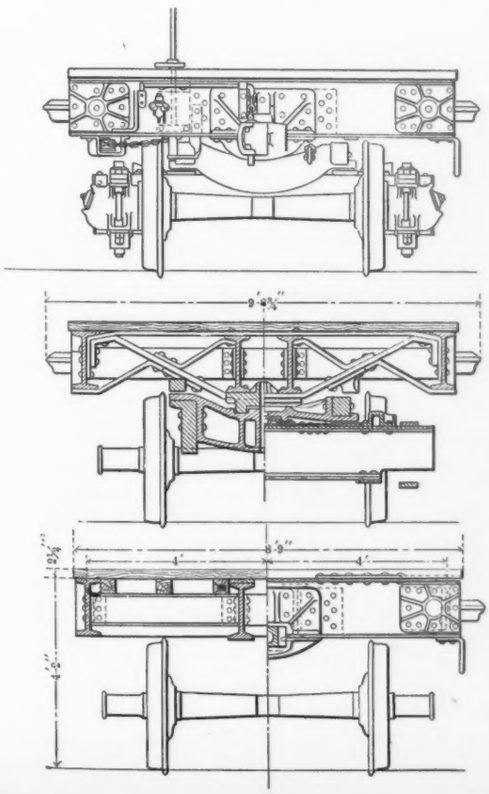
In the original discussion of the general features of the design it was decided that the car should have standard M. C. B. parts as far as possible, so that it could be easily repaired anywhere in the United States. This was particularly desirable in connection with wheels, axles, journal boxes and truck parts. Following up that idea, it was decided to use two 100,000-lb. standard trucks under each end of the car, these to be connected by a heavy cradle, in the centre of which would be the bearing for the car body and under which the trucks would have free movement.

This cradle connecting the two trucks consists of two short but very strong and carefully designed bolsters resting upon the truck bolster, which are connected by two heavy cast-steel side bars, in the centre of which is a cast-steel bolster on which the car body rests. This design is shown very clearly in the illustrations and its remarkable simplicity and strength are apparent. The bolsters resting over the trucks are broad and the truck centre bearing is located as high as possible, the strength being obtained by the deep flanges extending down on either side of the truck bolster. The side bars, which are 5 ins. square at the ends where they connect to end castings, are gradually made deeper and narrower until they measure 4 ins. thick and 14 ins. deep at the centre, the top at the centre being depressed 2 ins. for a distance to accommodate the centre castings. This centre casting is of steel and made deep and heavy, as it has to support a weight of 100,000 lbs. besides half of the car body. The lips passing over the side rails are extended beyond and form a bearing for the side bearings. The centre plate, which is cast integral with the bolster, is sunk down as low as possible, its bearing surface being 4 ins. below

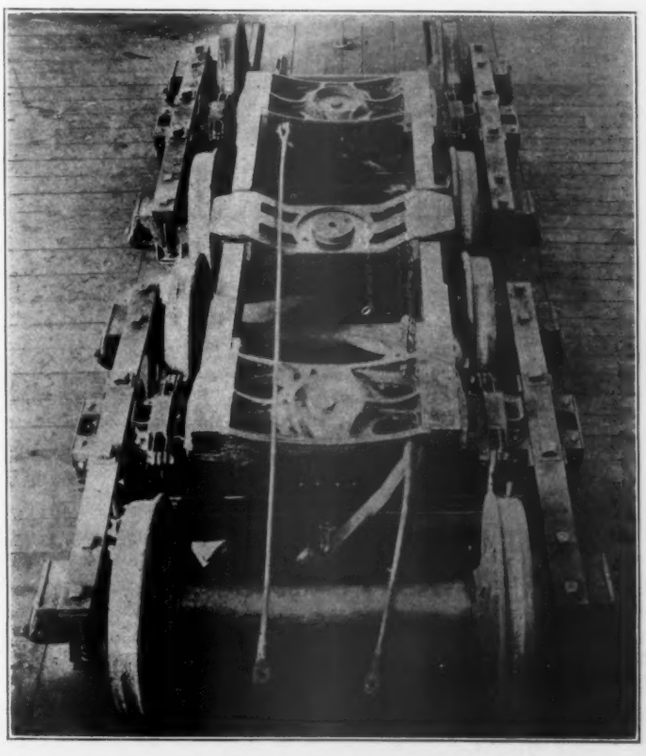
100-TON CAPACITY FLAT CAR.—ALLIS-CHALMERS CO.




100-TON CAPACITY FLAT CAR.—SECTIONS, ELEVATIONS AND PLAN OF CRADLE.




100-TON CAPACITY FLAT CAR.—SECTIONS AND END ELEVATION.



100-TON CAPACITY FLAT CAR.—VIEW OF TRUCKS AND CRADLE.

the level of the side rail. This cradle spaces the trucks at 8 ft. 9 in. centres, giving them room to curve freely. The bolsters over the trucks are given very slight side clearance, so that the rocking tendency at this point is very small.

The car body, which measures 40 ft. over end sills, is of simple but very strong design and consists essentially of four 15-in. 100-lb. I-beams running continuously from end sill to end sill, the two forming the centre sills being spaced 12⅞ ins. between webs and the two side sills at 8-ft. centres. The centre sills are located 1 in. lower than the side sills. These are connected at the ends by 15-in. 55-lb. channnels with the flanges outward, which are fastened to the sills with very heavy corner irons securely riveted. For adding stiffness and strength at the corners there are ½ by 18-in. gusset plates across the corners, and 1 by 8-in. diagonal braces from the end sill to the centre sill. At ten equally distant points there are 8-in. 21¼-lb. channel irons fitted between the centre and side sills and securely fastened to both by angle irons in the corners. At these points 1 by 8-in. flanged plates are fitted between the centre sills. These cross channels are located with their upper flanges 4 ins. below the top flange of the side sill and six 4 by 4-in. wooden nailing strips running from end sill to end sill are fastened to them and the floor of 2½-in. wood is nailed to these strips.

Because of the height of this car, which is 4 ft. 4½ ins. from top of floor to rail, it was necessary to cut out but a small section of the bottom of the end sill for the coupler shank to pass through, and at this point a heavy ribbed malleable casting acting as a stiffener has been fitted. On the outer end of each end sill are also heavy malleable iron push pocket plates.

The car bolster, which is located 8 ft. 9 ins. from the inside of the end sill, consists, as is clearly shown in the cross-section of the car, of a very heavy trussed steel plate design. Extending across the top of the two centre sills and flanged downward and riveted to the inside of the web of the side sills are two 1 by 10 in. plates spaced 12 ins. apart. Passing below the centre sills and extending upwards to the connection of these cover plates at the side sills, at which point it is flanged down and securely riveted to both, are two 1½ by 10 in. plates. Diagonals are carried from the bottom of the side sills and from the top of the centre sills to these heavy trusses. The centre plate of heavy cast steel fits and is fastened to the bottom of the centre sills and the bolster trusses, as is clearly shown in the cross sections. The side bearings are simple castings fastened to the body bolster and bearing on the extension of the centre truck bolster mentioned above.

One of these cars has been tested for curving and it was found that it would take a 16-deg. curve without trouble. It is believed that they will take any curve over which other cars are operated.

We are indebted to Mr. James F. DeVoy, mechanical engineer of the Chicago, Milwaukee & St. Paul Railway for the drawings and photographs shown herewith.

## PRODUCTION IMPROVEMENTS.

The accompanying illustrations show some special devices which are being used with good results at the Winona (Minn.) shops of the Chicago & Northwestern Railway Company.

Fig. 1 shows the application of a special mandrel and tool holders for turning eccentrics on a boring mill, and Fig. 2 shows the mandrel and also a chuck used for boring the eccentrics. The tool holder at the left, in Fig. 1, carries two high-speed tools ¾ in. square, and the holder at the right has four high-speed tools ¾ in. square set at the proper distance for web-

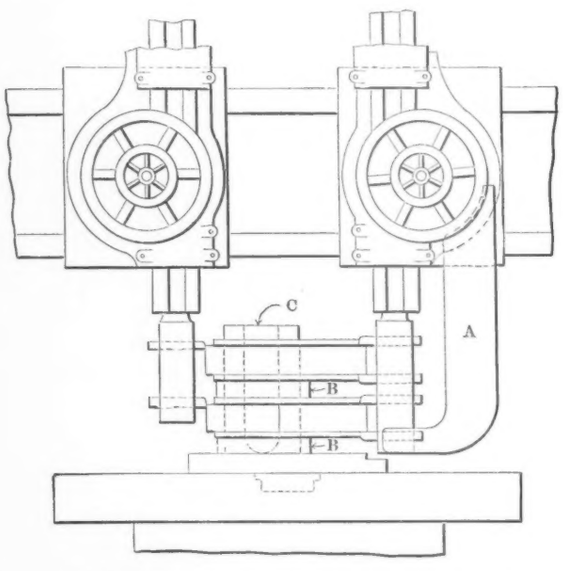



FIG. 1.—TURNING ECCENTRICS ON BORING MILL.

bing the eccentrics. A is a special brace for stiffening this tool holder, C is the mandrel, B-B are parting rings. In handling the eccentrics they are first planed and drilled and then placed in the chuck and bored, after which they are taken to a slotter and key-seated. They are then taken back to the boring mill, slipped on the mandrel, turned and webbed. With this arrangement three eccentrics are bored out per hour or two can be turned. The chuck can be designed to take care of eccentrics with a maximum throw, and can be fitted with set screws for adjusting it for other designs.

Fig. 3 shows a jig for drilling the driving wheel and eccentric keyways. The jig is slipped over the axle with the driving wheel keyway hole D central with a line scratched longi-

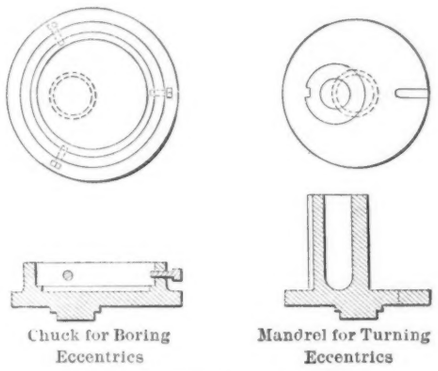



FIG. 2.—CHUCK AND MANDREL.

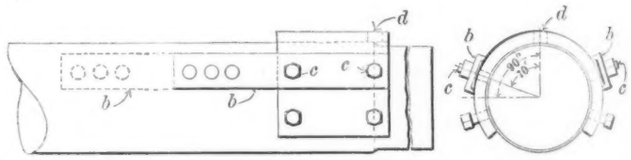



FIG. 3.—JIG FOR DRILLING DRIVING WHEEL AND ECCENTRIC KEYWAYS.

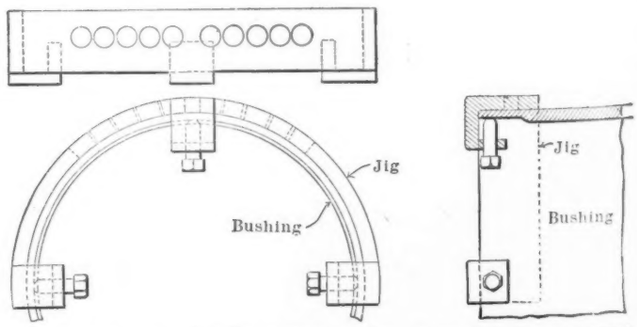



FIG. 4.—JIG FOR DRILLING STEAM PORTS IN CYLINDER BUSHINGS.

tudinally on the axle when it is in the lathe. The arms b-b are set to a line on the jig. They are then tightened and held in place by nuts on the studs (c). This device saves

two hours of laying off by a high-priced machinist, and is so simple that it may easily be handled by a drill press boy.

The jig for drilling cylinder bushings for the steam ports (Fig. 4) is very simple. The lathe operator, while turning the bushing, scratches a line longitudinally on it and also a line at each end around the circumference at the center of the steam ports. All the drill press boy has to do is to set the jig central with these lines. We are indebted for drawings and information to Mr. V. T. Kropidlowski.

## SUPERHEATED STEAM ON THE CANADIAN PACIFIC RAILWAY.

At the April meeting of the New York Railway Club Mr. H. H. Vaughan, assistant to the vice-president of the Canadian Pacific Railway, presented a paper on the use of superheated steam on that road. This paper, which deals largely with the results which have been obtained on the Canadian Pacific Railway, the pioneer in the introduction and use of superheated steam in this country, supplements the individual paper which was presented by Mr. Vaughan at the last meeting of the Master Mechanics' Association. The Vaughan and Horsey, or C. P. R. type of superheater, which has been developed since the first paper was written, was fully described on page 41 of our February, 1906, issue. The engines which were considered in the tests reported by Mr. Vaughan are as follows:

| Class. | Type. | Number. | |
|---|---|---|---|
| 700 | 4-6-0 | 10 | Schmidt fire tube superheater. |
| 710 | 4-6-0 | 55 | Schenectady superheater modified. |
| 740 | 4-6-0 | 30 | Vaughan & Horsey, or C. P. R. superheater. |
| 1200 | 2-8-0 | 41 | Schenectady compound, no superheater. |
| 1300 | 4-6-0 | 37 | Schenectady compound, " " |
| 1600 | 2-8-0 | 20 | Schmidt fire tube superheater. |
| 1621 | 2-8-0 | 21 | Schenectady superheater ("Field" tube type). |

The following are extracts from Mr. Vaughan's paper:

The "Schmidt," "Schenectady" and "C. P. R." superheaters now being applied on the Canadian Pacific are identical in every respect with the exception of the arrangement of the headers and the connection to them of the superheater pipes. The primary objects sought in the design of the "C. P. R." type were the separation of the joints from the heater pipes to the headers, the location of these joints in a position where they could be conveniently inspected and an arrangement of the superheater pipes that would permit any individual element being removed or applied without disturbing the others. These objects appeared desirable after the experience on earlier engines, and it is evident they have been very satisfactorily obtained. The first is also satisfactorily met in the "Schmidt" by the separate bolting of the superheater pipe flanges to the header, and its need did not develop to any great extent in the earlier engines with the "Schenectady," although later experience would suggest its necessity, as more or less trouble is developing with the joints between the superheater pipe and main headers. Both the second and third requirements are also partially met by the "Schmidt," but not as thoroughly as in the "C. P. R." design, and in both respects the "Schenectady" is deficient. It must not be understood that either of these types gives especial trouble in service or are difficult to maintain; in fact, the reverse is the case; but the points mentioned are conveniences and advantages which are believed to have been obtained by the modification illustrated, and their value will be appreciated from the roundhouse point of view.

The most important question in connection with superheaters is naturally that of the coal economy obtained, and this is not easily determined, as all who have followed the effect of different improvements or proportions of locomotives will appreciate. Tests are open to the objection that they do not represent general service conditions and coal records on account of their inaccuracy and lack of definite results. Tests on superheaters present, however, an additional difficulty over those directed to ascertain the relative economy of simple versus compound engines, or of wide versus narrow fireboxes, where the efficiency of either the boiler or engines alone is involved, in that they must necessarily include the efficiency of the machine as a whole. The determination of the water consumption per unit of work is not sufficient, as it is quite possible for any advantage shown in this respect to be neutralized by less efficient boiler performance. Even with equal boiler efficiency, the additional heat in the superheated steam would represent a reduction in the water evaporated of 1-20 of 1 per cent. for each degree of superheat, or 5 per cent. for 100 deg. and 10 per cent. for 200 deg. superheat. In other words, if an engine with 100 deg. superheat showed a saving in water consumption of 5 per cent., in comparison with an ordinary engine, and the boiler was equally efficient, there would be a saving in coal, and there must in addition also be some loss in boiler efficiency on account of the necessarily higher temperature of at least a portion of the smokebox with any design of superheater. This action has been discussed at length in the writer's previous paper and need not be further referred to, but, on account of it, it is necessary in comparing superheaters with other engines to measure the coal consumption per unit of work. To do this a rather extensive series of tests are required to average the influence of the efficiency of the firing with a dynamometer car to measure the work done, and owing to the latter not having been available during the past year it has been impossible to undertake them. During the past winter a car has been constructed which will enable some experiments to be made, but at present the only figures available are those showing the tons hauled and coal consumed on the various sections of the road, and as these, after all, are the final arbiters of economical working, they afford, so far as they are susceptible of proper comparison, the most satisfactory evidence that can be obtained. Such figures are not of great value when applied to individual engines, but when obtained from a number of engines, without specially selected crews, working together in regular service they must certainly be regarded as reliable.

The two general classes of superheaters, consolidation and ten-wheel freight engines, can only, on the Canadian Pacific, be compared with compound engines, as there are no simple freight engines in use on that road at all similar in size or design. Compounding has during the past few years become firmly established for freight service, and on account of the high cost of coal there would be no question as to its continuance had not the use of superheaters been introduced. Of compound engines there are, however, two classes which afford excellent comparisons; the 1200 class consolidation, of which there are forty-one in use, and the 1300 class ten-wheelers, of which there are thirty-seven. Both these classes are modern "Schenectady" compound engines, and although the 1200 class is rather lighter than the 1600, it has the same grate area and is a good engine for comparative purposes, while the 1300 class is practically identical with the 700 class, with the exception of the change from compound to simple superheaters.

The dimensions of the various classes are given in the following table. In comparing road coal records a good many difficulties are met with, some of which are usual on all roads, while others apply particularly to the Canadian Pacific Rail-

| | 1,200 | 1,300 | 1,600 | 1,621 | 700, 710 & 740. |
|---|---|---|---|---|---|
| Boiler pressure | 200 | 200 | 200 | 200 | 200 |
| Firebox width, inside | 65⅜ | 70¼ | 65¼ | 65¼ | 69⅞ |
| " length, " | 96" | 102⅛" | 96⅜" | 102⅛" | ..... |
| Number of ordinary tubes | 281 | 378 | 244 | 255 | 244 |
| Diameter of ordinary tubes | 2" | 2" | 2" | 2" | 2" |
| Number of special tubes | ..... | ..... | 22 | 55 | 22 |
| Diameter " " | ..... | ..... | 5 | 3 | 5 |
| Length of tubes | 14'2" | 14'-6⅛" | 14'-1⅜" | 14'-2⅜" | 14'-2⅜" |
| Number of superheater pipes | ..... | ..... | 88 | 55 | 88 |
| Diameter superheater pipes | ..... | ..... | 1¼ | 1¼ | 1¼ |
| Heating surface tubes | 2,084 | 2,885 | 2,216 | 2,705 | 2,233 |
| " " firebox | 134 | 180 | 165 | 165 | 180 |
| " " total | 2,218 | 3,065 | 2,381 | 2,870 | 2,413 |
| Superheating surface | ..... | ..... | 375 | 340 | 378 |
| Grate area | 43.6 | 50.0 | 43.6 | 43.6 | 50.0 |
| Cylinders | 22x35 | 22x35 | 21x28 | 21x28 | 21x28 |
| Driving wheels | 57 | 63 | 57 | 57 | 63 |
| Total weight of engine | 159,500 | 190,000 | 186,200 | 186,200 | 190,000 |
| Weight of drivers | 140,500 | 142,000 | 163,700 | 163,700 | 141,000 |
| Weight of tender | 114,000 | 122,000 | 121,500 | 121,500 | 122,700 |
| Water, imperial gals. | 5,000 | 5,000 | 5,000 | 5,000 | 5,000 |
| Coal, tons | 10 | 10 | 10 | 10 | 10 |

way. The easiest figures to arrive at, those based on general averages, are not by any means reliable, and considerable of the peculiar traffic conditions moved from one section to another more than is usual on most roads. Most engines have assigned crews, and in consequence those engines doing the greatest amount of work on any section as a rule give better relative results than those making fewer trips, as the latter are extra crewed and the men are not so interested with the results. Taking these points into consideration, it will be seen that records made during the summer where weather conditions are most equable afford, on the whole, the most reliable results; provided the different engines do sufficient work on a section to reach a fair average, and this can be most easily watched by noting the total amount of coal consumed. The following table shows the results obtained from the 1200, 1300, 1600 and 1621 class engines on the various sections of the Lake Superior division for the months of May to October, 1905, the column relative to consumption showing the consumption reduced to the 1200 class as 100:

| SECTION. | Class of Engine. | Number of Class Hauled. | Total Coal Consumed. | Coal Consumed Per Unit Mile. | Relative Consumption. |
|---|---|---|---|---|---|
| Chalk River—North Bay.... | 1621 | 7 | 3,048¾ | 128 | 97 |
| | 1600 | 5 | 964½ | 112 | 85 |
| | 1300 | 3 | 175 | 114 | 86 |
| | 1200 | 8 | 1,121¾ | 132 | 100 |
| North Bay, Cartier, Webbewood..... | 1621 | 7 | 1,473¾ | 127 | 104 |
| | 1600 | 7 | 588¾ | 106 | 87 |
| | 1300 | 4 | 510¾ | 113 | 92 |
| | 1200 | 12 | 1,758 | 122 | 100 |
| Schrieber—Fort William ... | 1621 | 5 | 1341½ | 145 | 122 |
| | 1600 | 3 | 34¾ | 96 | 81 |
| | 1300 | 4 | 743¾ | 141 | 118 |
| | 1200 | 16 | 3,876 | 119 | 100 |
| White River, Schrieber..... | 1621 | 6 | 274¾ | 159 | 119 |
| | 1600 | 3 | 89 | 134 | 101 |
| | 1300 | 4 | 775¼ | 150 | 113 |
| | 1200 | 17 | 4 788¼ | 133 | 100 |
| Chapleau—White River.... | 1621 | 3 | 265 | 140 | 96 |
| | 1600 | 11 | 4,126¾ | 121 | 83 |
| | 1300 | 3 | 845¼ | 142 | 97 |
| | 1200 | 15 | 515 | 146 | 100 |
| Cartier—Chapleau ..... | 1621 | 4 | 245¼ | 126 | 82 |
| | 1600 | 10 | 3,684¾ | 117 | 76 |
| | 1300 | 4 | 565½ | 148 | 96 |
| | 1200 | 10 | 728¼ | 154 | 100 |

These records must certainly be regarded as satisfactory evidence in favor of the superheaters of the 1600 class, but it must be noted that between Schrieber and Fort William and Schrieber and White River these engines did not do sufficient work for the results to be of any value. On the remaining four sections the results show their relative economy to be 85, 87, 83 and 76 compared with the 1200 class, which is fairly conclusive. The 1621 are evidently not quite as economical as the compound, which is accounted for by there only obtaining about 20 deg. of superheat as against 80 deg. to 100 deg. in the 1600 class, as shown in the diagrams reported to the Master Mechanics' Association.

The above statement covering the summer months is the only one that can be properly averaged, and it does not include any of the 700, 710 or 740 class engines. These were delivered in September, 1905, and immediately went into service on the Central division between Fort William and Winnipeg, where they can be compared with a number of the 1300 class working in the same district. There are three sections on this piece of line, and as the relative economy of the engines varies with the sections they must be given separately.

These sections vary considerably in their grades and traffic conditions from the Lake Superior division. On the latter the grades are nominally 1 per cent., with an undulating profile, and on such a line a consolidation engine is more economical than a ten-wheeler. Between Winnipeg and Fort William the line is fairly level, and as the load is heavy, the work uniform, and the speed fairly high, the 1300 class has been found to be the most economical engine that could be obtained. The following table indicates the difficulty in comparing coal records, but the conclusions would be that the 700 and 710 classes are equal to the 1300 class between Winnipeg and Kenora, slightly inferior to it between Kenora and Ignace, and slightly superior between Ignace and Fort William, while on the latter section the 740 class are decidedly more

| Month | 1300 Class. | | 700 Class. | | 710 Class. | | 740 Class. | |
|---|---|---|---|---|---|---|---|---|
| | Coal Consumed. | Coal per unit mile. | Coal Consumed. | Coal per unit mile. | Coal Consumed. | Coal per unit mile. | Coal Consumed. | Coal per unit mile. |
| **Fort William to Ignace.** | | | | | | | | |
| Sept. | 1471 | 98 | 48 | 123 | 121 | 114 | 1082 | 79 |
| Oct. | 3712 | 102 | 75 | 100 | 352 | 104 | 2252 | 88 |
| Nov. | 3922 | 103 | 91½ | 82 | 175 | 98 | 1881 | 93 |
| Dec. | 2510 | 113 | 74 | 101 | 1162 | 104 | 626 | 96 |
| Jany. | 1528 | 109 | . | ... | 1182 | 100 | .... | .. |
| Feby. | .... | ... | .. | ... | .... | ... | ... | .. |
| **Ignace to Kenora.** | | | | | | | | |
| Sept. | 480 | 100 | 907 | 90 | 1614 | 98 | .. | .. |
| Oct, | 1289 | 99 | 1927 | 104 | 3672 | 109 | .. | .. |
| Nov. | 573 | 111 | 1774 | 106 | 3925 | 114 | .. | .. |
| Dec. | 146 | 116 | 919 | 101 | 3367 | 113 | 10 | 97 |
| Jany. | 32½ | 154 | 546 | 115 | 2405 | 113 | .. | .. |
| Feby. | .. | ... | .... | ... | .... | ... | .. | .. |
| **Kenora and Winnipeg.** | | | | | | | | |
| Sept. | 785 | 93 | 405 | 93 | 1550 | 91 | ... | ... |
| Oct. | 2416 | 103 | 462 | 100 | 3090 | 101 | ... | ... |
| Nov. | 2324 | 104 | 308 | 120 | 2872 | 110 | 29½ | 101 |
| Dec. | 1727 | 115 | 471 | 119 | 1873 | 115 | 11 | 102 |
| Jany. | 1167 | 114 | 524 | 106 | 1058 | 117 | ... | ... |
| Feby. | .. | . | ... | ... | .... | ... | ... | ... |

economical than either of the others. It is evident, however, that to average these figures would not give an accurate result on account of the variable amount of work done each month. The most satisfactory plan, if records were absolutely accurate, would be to continually compare with one class, and the average increase or decrease could then be obtained. It can easily be seen that if the class compared with used a small amount of coal during any one month the comparisons made with it might be widely misleading; for instance, were the 1300 class taken as a standard, the results of the other engines would show an enormous economy in January between Ignace and Kenora. If, however, in each month the engine using the largest amount of coal is taken as a standard, and the amounts which the other classes would have consumed at its rate are calculated, a comparison of the coal actually used as against that which would have been used is obtained which affords a reasonable measure of their economy. A hypothetical illustration of this method is as follows:

| Month. | 1200 class. | | 1600 class. | | 1621 class. | |
|---|---|---|---|---|---|---|
| | Coal consumed. | Coal per unit mile. | Coal consumed. | Coal per unit mile. | Coal consumed. | Coal per unit mile. |
| May..... | 680 | 120 | 796 | 115 | ..... | ..... |
| June..... | 80 | 105 | 600 | 118 | 500 | 135 |
| July..... | 110 | 130 | 100 | 140 | 900 | 130 |

Results by comparing with class burning most coal

| Month. | 1200 class. | | 1600 class. | | 1621 class | |
|---|---|---|---|---|---|---|
| | Used. | Equivalent | Used. | Equivalent | Used. | Equivalent |
| May..... | 680 | 650 | 796 | 796 | .... | .... |
| June ..... | 80 | 90 | 600 | 600 | 500 | 436 |
| July..... ... | 110 | 110 | 100 | 93 | 900 | 900 |
| Total..... | 870 | 830 | 1496 | 1489 | 1400 | 1336 |
| Relative Consumption .. | 102.5 | | 100.5 | | 105.0 | |
| Or ..... | 100 | | 98 | | 102.5 | |

This method tends to minimize the variations which occur, and is thus conservative in its results; it is also inapplicable where the classes of engines to be compared do not work together on the same sections to a sufficient extent to obtain fair comparison, and is thus in some ways not as satisfactory as deductions drawn from a study of the records; but it has the advantage of eliminating all personal element, and is the

only system so far devised by which any reasonable compilation of records extending through several months on various sections can be made.

The records given above for the Central division, September to January, inclusive, when compared in this manner yield the following results:

| Section. | 1300 | | 700 | | 710 | | 740 | |
|---|---|---|---|---|---|---|---|---|
| | Coal Used | Relative Consumption | Coal Used | Relative Consumption | Coal Used | Relative Consumption | Coal Used | Relative Consumption |
| Fort William to Ignace | 13,144 | 100 | 207 | 101.0 | 2 998 | 88.5 | 5,842 | 84.7 |
| Ignace to Kenora | 2,520 | 100 | 6,073 | 98.3 | 14,982 | 105.0 | . | ..... |
| Kenora to Winnipeg | 8,416 | 100 | 2,170 | 100.8 | 10,443 | 100.5 | .... | ... |
| Total | 24,080 | 100 | 8,450 | 100.7 | 28,418 | 99.5 | 5 842 | 85.5 |

The records on the Lake Superior Division for the months of May to January inclusive when compiled in the same way give the following results:

| SECTION. | 1200 | | 1600 | | 1621 | | 1300 | | 710 | | 740 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Coal | Consumptn | Coal | Consumptn | Coal | Consumptn | Coal | Consumptn | Coal | Consumptn | Coal | Consumptn |
| Chalk River—North Bay | 3122 | 100 | 1361 | 905 | 3709 | 102. | 253 | 100.6 | ..... | ..... | 169 | 10.7 |
| North Bay—Cartier | 3571 | 100 | 880 | 94.8 | 2248 | 104.6 | 823 | 91.2 | ..... | ..... | 245 | 94.2 |
| Cartier—Chapleau | 1809 | 100 | 6990 | 84.6 | 432 | 98.2 | 1275 | 95.6 | 5:3 | 89 | 668 | 96.7 |
| Chapleau—White River | 1448 | 100 | 7563 | 93.2 | 459 | 108.5 | 1618 | 103.0 | 642 | 102 | 491 | 90.4 |
| White River—Schreiber | 7999 | 100 | 586 | 112.2 | 1465 | 106.7 | 936 | 111.6 | 325 | 100 | 457 | 93.7 |
| Schreiber—Fort William | 7068 | 100 | 430 | 106 | 1564 | 109.7 | 933 | 113.5 | 402 | 102 | 628 | 90 0 |
| Total | 25012 | 100 | 17790 | 98.5 | 9877 | 104 | 5838 | 106.5 | 1944 | 104.2 | 2,178 | 94 |

It is interesting to note that the above results may also be compared as follows using the compounds of each type as a basis.

| DIVISION. | TYPE. | COMPD. | SCHMIDT | SCHEN. A | SCHEN. B | C. P. R. |
|---|---|---|---|---|---|---|
| Lake Superior | Consolidation | 100 | 98.5 | 104 | ..... | .... |
| | Ten Wheel | 100 | ... . | .·. .. | 98.0 | 88.0. |
| Central .... | Ten Wheel | 100 | 100.7 | . . | 99.5 | 85.5 |

Assuming these comparisons to be accurate, and after careful study the writer certainly believes them to be conserva-

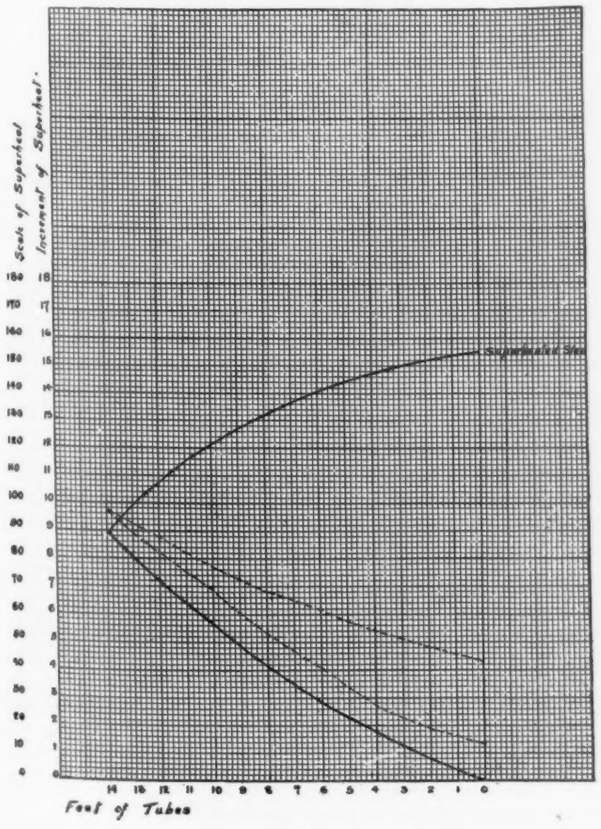



FIG. 10.

tive, the superheater locomotive has evidently shown itself to be rather more economical than the compound with the amount of superheat obtained, on the "Schmidt" and "Schenectady B" design, and from the good results obtained from the C. P. R. engines there is every reason to believe that still further economies will be reached. The results from these engines were entirely unexpected, as the design was developed from a mechanical standpoint entirely, and they are not by any means easy to explain, except that they must be caused by the steam being heated to a higher temperature than in the

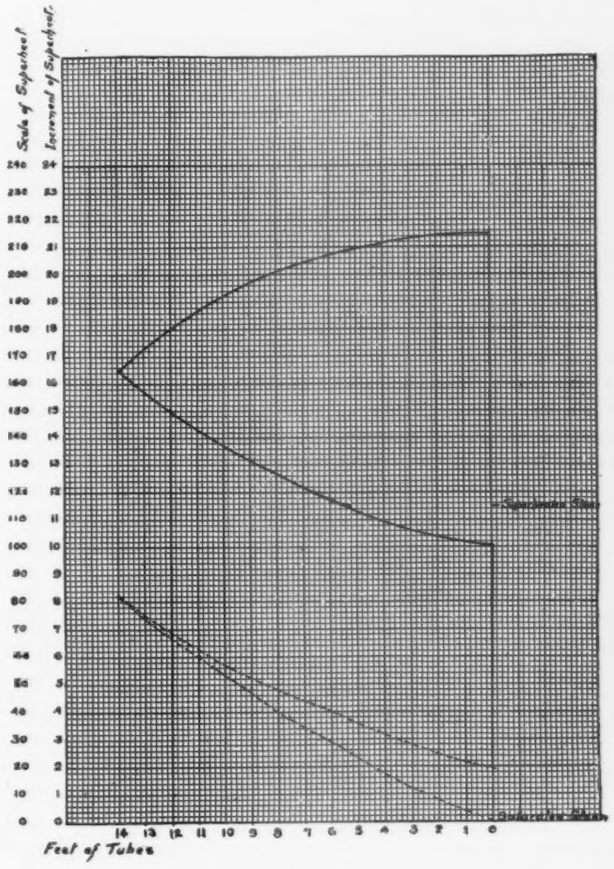



FIG. 11.

"Schmidt" or "Schenectady" engines. Since this was not discovered until December, it has been impossible to carry out proper temperature tests, on both types, but one made on one of the 740 class engines would indicate a higher superheat of about 40 deg. In view of the superheating surface being identical, this can only be explained by the peculiar arrangement of the headers which prevents any abstraction of heat from the steam after it has been superheated by the entering steam by the tendency to a more equal flow of the steam through the various superheater pipes in passing from one header to another. In support of the first reason the poor results obtained from the "Schenectady A" type are of interest. With 340 square feet of superheating surface against 375 in the "Schmidt" engine, the superheat was only about 20 deg., as against 100 deg. This would show that any reduction in the temperature of the superheated steam by transferring its heat to the entering saturated steam is not as might be expected compensated for, and that the degree of superheat finally obtained may be seriously diminished by such action. The reason for this is not very clear, but a key to it may be found in the following diagrams, which have been worked out on the following data:

(a) Firebox temperature 2,000 deg., smokebox temperature 800 deg., flue 16 ft. long (at point 1. from firebox) = $2{,}000 - 200\sqrt{l}$.

(b) Radiation from superheater tubes equal to that from blackened copper in vacuo = .0854 BTU per min. per square foot per degree F.

(c) Boiler with 88 superheater pipes 1¼ in. O. D. 12 ft. long using 20,000 lbs. steam per hour with 150 deg. superheat without abstraction of heat after superheating.

(d) Specific heat of superheated steam 0.6.

The full lines show the temperature of the superheated steam on its passage from the header through the tubes and back, and the dotted lines the increment of temperature per ft. Fig. 10 shows the form of these curves when the steam enters the tubes at boiler temperature, and Fig. 11 where its temperature has been raised 100 deg. by contact with the superheated steam, which in its turn is lowered 100 deg. by this action. It will be seen that there is a loss of 50 deg. by the transfer of heat on account of the increased radiation from the superheater pipes to the boiler, and the decreased transmission of heat from the flue gases to the superheater tubes. These diagrams are not presented with the idea that they are quantitatively accurate, but to illustrate the actions which account for the loss when heat is transferred from the superheated to the saturated steam.

The results obtained from engine 820 in passenger service have been very encouraging as have also those from the Pacific type. A graphic record of a test made on No. 820 (AMERICAN ENGINEER, February, 1906, page 42), shows that the superheat obtained varies from 160 deg. to 200 deg. at the steam chest. This engine has been in service since last June on the Lake Superior division between Chalk River and North Bay, and the results for five months, June to October inclusive, compared to those obtained from two other identical engines on the same section, were as follows:

| Eng. No. | Tons consumed. | Lbs. coal per gross ton mile. | Relative consumption. |
|---|---|---|---|
| 820 | 734 | 143.5 | 100 |
| 823 | 763 | 160.0 | 111.5 |
| 838 | 913 | 199 | 138.5 |

There is a difference in the runs in which these engines are employed, all making three stops, but engine 820 having 11 flag stops against two for the other engines, which would, of course, increase the relative consumption of 820, so that while unsatisfactory on account of these figures referring to one engine there is still but little doubt that the superheater is very satisfactory and economical in passenger service, and its relative economy does not decrease with increase of speed as is the case with compounds. The repair question is so far unimportant and nothing has developed to show that superheater engines will exceed appreciably simple engines when expenses that are fairly due to experimental construction are excluded. Lubrication on a superheater is identical with that on a simple, with the exception of the additional cylinder connection required, and what is wanted is simply to deliver the oil to the required spot.

In conclusion the writer sees no reason to change the opinion previously arrived at that the superheater steam locomotive attains equal or greater economy than the compound without any of its disadvantages, and would now add to this by stating that the employment of higher temperatures with the still further economy is relatively practical and to that on engines now under construction the proportions of superheating surface will be increased to attain this result. It is especially advantageous in passenger service and so far no counterbalancing disadvantages have been developed which are worth considering. Whether this is due to special conditions on the Canadian Pacific Railway, or not, superheating is certainly successful on this road, and there is so far no inclination to discontinue it.

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THE INTERNATIONAL RAILWAY MASTER BOILER MAKERS' ASSOCIATION.—The fifth annual convention of this association will be held at the St. Charles Hotel, Milwaukee, Wis., beginning May 15th. Committees will report on the following topics: Progressive tools for boiler works; handling of engines on ash pits and in roundhouses, also proper regulation of dampers; best method of inspecting and testing locomotive boilers; modern design and construction of locomotive boilers; Belpaire vs. radial-stay boilers; arch tubes and arch bricks, what benefit and how applied; best method of applying and maintaining staybolts in all their forms; how to remedy cracked and leaky mud rings.

## THE PENNSYLVANIA RAILROAD'S EXTENSION TO NEW YORK AND LONG ISLAND.

*(Continued from page 179.)*

sion main circuits, together with the cross section of the electrical gallery given herewith, show the general arrangement of the wiring and the location of the instruments. In the diagrammatical view of the high tension circuit the three conductors of the three-phase circuit are shown as one line. The generators are designed to run in parallel on either of two sets of main bus bars, called the working and the auxiliary bus, but one set of which is generally in use. The cables from the generator run through conduits in the foundation to the basement of the electrical section, and thence to the main generator circuit breakers, which are of 600 ampere capacity each. From thence they pass the generator selector circuit breakers, of which there are two, one on each of the circuits to the two sets of bus bars. They are also of 600 ampere capacity. Between these circuit breakers and the bus bars are the main generator switches, consisting of four-pole high tension oil switches, the fourth pole being for the grounded neutral connection.

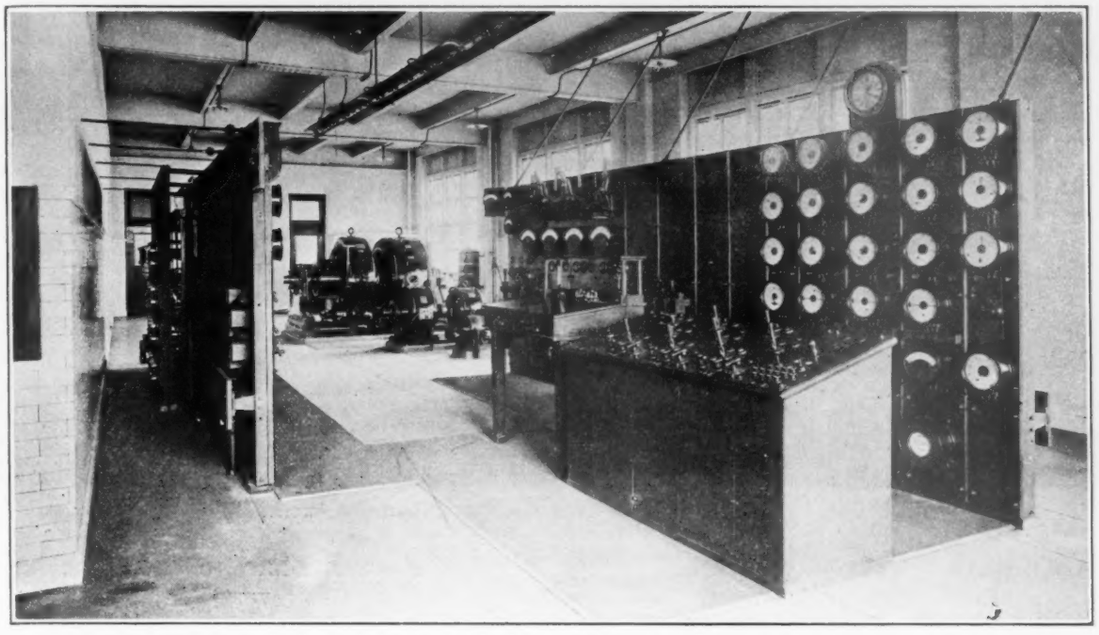
The feeder circuits are taken through feeder circuit breakers from group bus bars, each of which is arranged to accommodate six feeder circuits. These groups of buses have connections to the two main sets of bus bars through group selector circuit breakers of 1,200 ampere capacity and three-pole oil switches. By this arrangement any group of feeders can be connected to either the working or the auxiliary bus bars, which in turn can also be connected to any generator or number of generators.

All of these switches, circuit breakers, bus bars, etc., are located in the three lower floors of the electrical section, enclosed in thoroughly insulated receptacles, and while arranged for convenient inspection the possibility of any short circuits or grounding of the apparatus is practically eliminated. All of the movable apparatus is operated by means of electro-magnets controlled from the operating gallery.

The low tension exciting circuits also have two sets of 250 volt bus bars, to which are connected the different exciting systems through the proper circuit breakers and main switches. This arrangement is clearly shown in the diagram. It will be seen that the current for the induction motor is transformed from one of the regular feeder circuits.

One of the views herewith shows the interior of the operating gallery, which is provided with an overhanging observation balcony, giving a good view of the whole engine room. In this room are located all of the instruments showing the condition of all the circuits as well as the control for operating the switches, circuit breakers, etc. The complete apparatus consists of the following: A generator control bench, which is in the form of a low desk with an inclined top, containing the operating handles for the generator main and selector switches, control for the generator main and selector circuit breakers, control for the turbine governor, control for the field switch and control for the field rheostat. On this bench are also the control for the switches connecting the different sections of the main bus bar. Directly in front of each generator panel on the bench is a vertical panel containing the generator instruments consisting of a voltmeter, ammeter, indicating wattmeter, power factor meter, etc. There is also a synchronizing lamp and a lamp indicating the position of the field rheostat, besides an illuminating indicator, forming the return signal from the engine room, on this board. These instruments are all operated by current derived from shunt potential transformers and series transformers suitably located in the leads from each machine.

The feeder switchboard, facing the generator board, consists of three vertical panels, each containing apparatus for the control of six feeders and two feeder group selector switches. Each panel contains ammeters, controllers for circuit breakers with indicating lamps and switch and circuit breaker control.



VIEW OF OPERATING AND INSTRUMENT BOARDS IN OPERATING GALLERY.—P. N. Y. & L. I. POWER HOUSE.

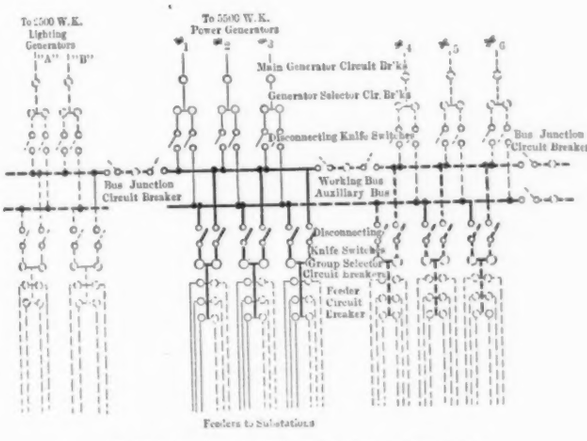



DIAGRAM OF HIGH TENSION CIRCUITS.

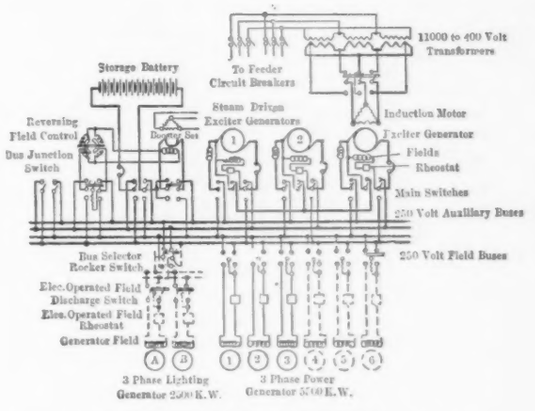



DIAGRAM OF LOW TENSION CIRCUITS.

The exciter switchboard is to the left of the generator instrument board and contains similar instruments and switches. A separate auxiliary switchboard controls the supply to the various direct current motors and lighting systems throughout the station and from it is also supplied the current required for operating the generator selector and feeder oil switches. From this point is also controlled the circuits for the electric telpherage system for the disposal of ashes, motor for operating the float bridge in the ferry house, boiler room elevator, hot well pump motors, engine room crane, air compressor and a number of other electrically operated devices throughout the station and vicinity.

ENGINE ROOM SIGNALS.—The system of signals for intercommunication between the engine men and the electrical operator, consists of a number of illuminated signs grouped together and located at a point visible from all parts of the engine room. The large letters and figures forming the signals are illuminated from behind by incandescent lights, which are lighted when the proper contact keys in the gallery are pressed. An answering system from the engine room to the gallery is also included.

A large synchronscope is mounted above the signals and from it the engine man is informed when the generator approaches synchronism, and is switched into service. There is also a load indicator located in the engine room and boiler rooms, which shows the operating force the condition and tendency of the station load,

MACHINE SHOP.—A complete machine tool equipment for making light repairs has been installed on the floor just above the electrical gallery. It consists of a forge, pipe threading machines, bolt cutter machine, lathe, planer, drill press, etc. These are arranged in two groups connected to shafts driven by induction motors. A swinging jib crane with a 25 ft. hoist is provided for lifting pieces from the engine room floor to the machine shop.

The first work of clearing the site for this station began on September 15, 1903, and the excavation on October 20th. The first turbine was started January 16, 1905, and the high tension was first turned into the transmission lines on April 27, 1905.

The station was planned and built by Westinghouse, Church, Kerr and Company, engineers for the Pennsylvania, New York and Long Island Railroad Company, which is the organization through which the Pennsylvania Railroad is carrying on its New York extension work. The design and construction were under the charge of Mr. George Gibbs, chief engineer of electric traction of the road and under the general supervision of the mechanical and electrical advisory committee—New York extension—a committee composed of officials of the Pennsylvania Railroad.

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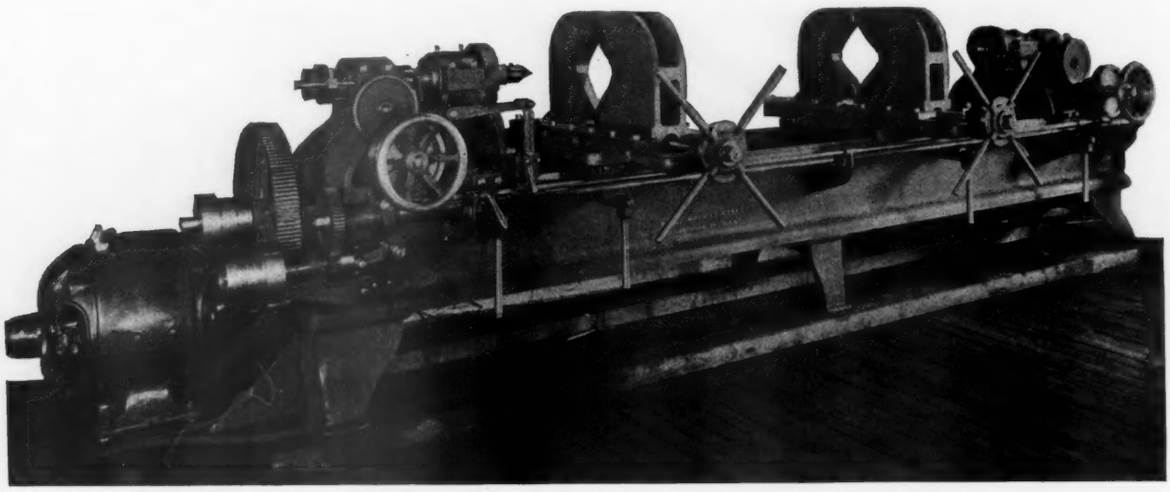
It was suggested at the Traffic Club of Pittsburg, that traveling gangs of car repair men could advantageously repair half the discarded cars where they stand.



DOUBLE HEAD CENTERING MACHINE.—THE NAZEL ENGINEERING & MACHINE WORKS.

## DOUBLE HEAD CENTERING MACHINE.

The double head centering machine illustrated herewith, one of which is in use at the Altoona shops of the Pennsylvania Railroad, is primarily designed for centering locomotive driving axles. It has a capacity up to 8 ft. 6 ins. in length, and the chucks will take axles from 4 to 14 ins. in diameter. The two chucks or vises are self-centering, and are adjustable along the bed. The centering heads are also adjustable along the bed. The spindles of the centering heads have a travel of 5½ ins., and may be operated either automatically or by hand, the large hand wheel in front of the heads being used for the hand feed, while worm wheels are operated by worms on the feed shaft for the power feed.

Above the feed shaft, which is the lower shaft running lengthwise of the bed, is a feed release rod which provides for the automatic release of both centering spindles when they have reached a predetermined depth. The capstan wheels in front of the bed are for closing the chuck jaws. The handles hanging down in front of the heads and chucks are ratchet levers for moving them along the bed. The machine is provided with three feeds, and is driven by a 5-h.p. General Electric 220-volt motor mounted on a bracket bolted to the machine, as shown. The rawhide pinion on the motor shaft meshes with the large spur gear on the machine. The machine, including the motor, occupies a floor space of 4 by 18 ft., and weighs about 10,000 lbs. It is made by The Nazel Engineering & Machine Works, Philadelphia.

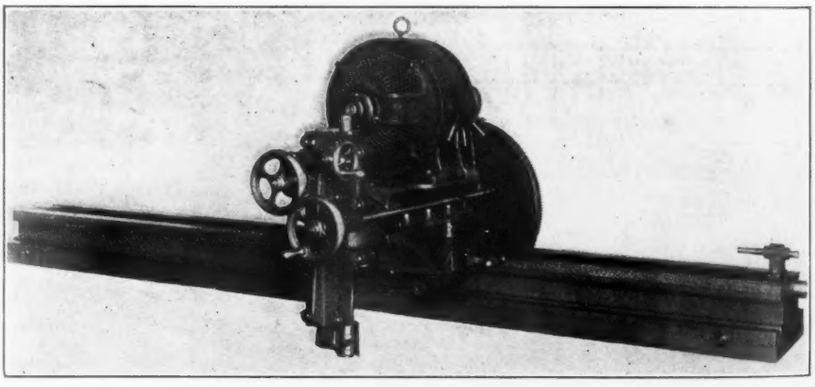
## BOOKS.

Valve Gears for Steam Engines. By Cecil H. Peabody. Second edition. Thoroughly revised. 142 pages, 33 folding plates. Published by John Wiley & Sons, New York, 1906. Price, $2.50.

This is a revised edition of the former book by the same author, and is stated to be intended to give engineering students instruction in the theory and practice of designing valve gears for steam engines. The authors aim has been to give the learner a firm grasp of the principles of valve gears and some facility in their application. Each type is illustrated by one or more examples selected from good practice. The book includes careful descriptive matter thoroughly illustrated by drawings of each type of valve gear now in use. All analytical demonstrations relating to principals are given in the appendix. The Zeuner valve diagram is used. Careful attention has been given throughout to make the book simple and easily understood. Problems and their solution are included in each chapter. This book will be found to be of value for reference as well as for instruction.

## PORTABLE MILLING MACHINE.

The portable milling machine, illustrated herewith, is designed for work up to 8 ft. in length. As it is motor-driven, it may be taken to the work, and thus can easily do work which could not be handled by other classes of tools. The carriage has a travel of 8 ft. with automatic feed; the cross slide has a movement of 12 ins.; the vertical spindle has a taper hole to receive taper shank mills, and has a movement of 10 ins.; the cross slide has a hand feed. The bed is mounted on a sub-base, and may be accurately adjusted by set screws and taper space pieces, which securely hold the two beds together. The sub-base is fitted with long slots and projections for attaching it to the work by clamps or bolts. This machine has been developed at the works of the Underwood Company, of Philadelphia, and has been added to the line of tools which they manufacture.



UNDERWOOD PORTABLE MILLING MACHINE.

## RAILWAY GENERAL FOREMEN'S CONVENTION.

The annual convention of the International Railway General Foremen's Association will be held at St. Louis, Mo., beginning Tuesday, May 8th, at 10 a. m. All sessions will be open to those interested in the mechanical department of railway service. Those eligible to active membership are: General foremen, superintendents of shops, division foremen, machine foremen, roundhouse foremen and assistants of railway locomotive repair shops. Applicants can be recommended by an active member or master mechanic, or superintendent of motive power. The Jefferson Hotel has been chosen as the official headquarters.

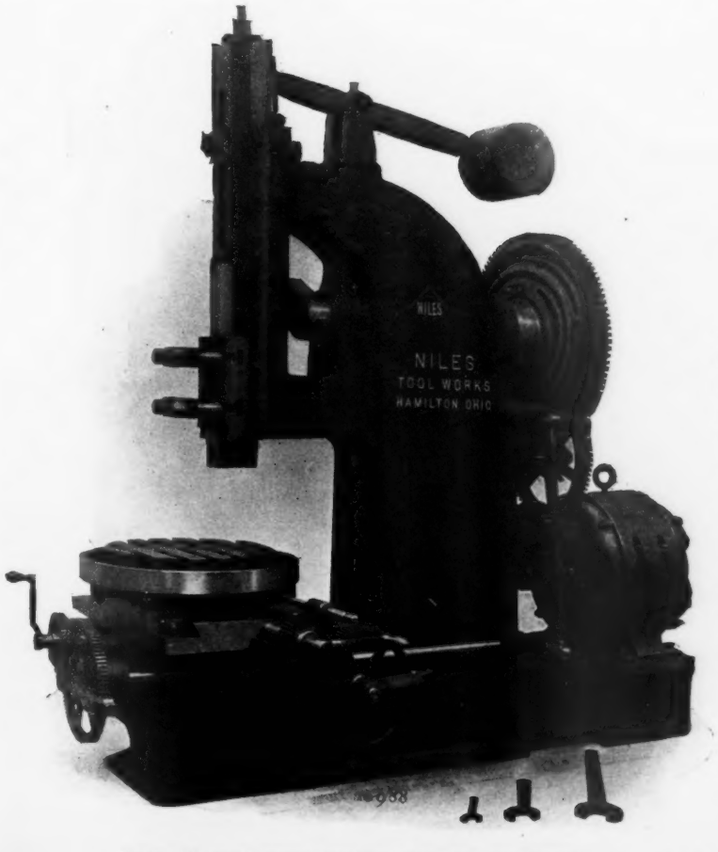
The following is the list of topics to be discussed: 1. How can we best organize to take every possible advantage of convention opportunities for the interchange of ideas and the

promulgation of the most advanced methods of shop procedures and discipline? Legitimate reasons why an organization of foremen should exist—Our aims and educational possibilities presented.—Paper by D. E. Barton. 2. Modern Machine Shop Practice. Its economic phase to include a statistical comparison with the year 1895.—Paper by Lee R. Laizure. 3. The Duties of the Foremen. Their relation to each other. The advisability of weekly or semi-monthly meetings of the shop foremen. The necessity for mechanical literature to the end that we keep in touch with the world of mechanics.—Paper by G. W. Keller. 4. Broken Frames. Which is the best method of welding a broken frame, by the use of Thermit or to take down and weld in the blacksmith shop?—Paper by C. H. Voges. 5. Pooling Engines. Do we get as good results by pooling engines as we do by having regular crews on them?—J. C. Wilkinson, chairman. 6. Electric Lights. What advantage has an electric light over the oil light, taking into consideration the expense of keeping it up and the effect it has on the eyes of the engineer?—A. S. Abbott, chairman. 7. Motive Power by Electricity. What relation will electricity have to the motive power on the railroads in the next ten years? Will it ever supersede steam, and will it ever be a success?—L. H. Raymond, chairman. 8. Cause of Leaky Flues. What causes leaky flues? Is it the handling of the engine, or the water used, or is it the workmanship?—B. E. Greenwood, chairman. 9. Qualities of a First-Class Roundhouse and Division Foreman.—Paper by G. H. Gates. 10. Pooling of Engines. Its mechanical and financial aspect.—Paper by W. H. Graves.

## 12-INCH SLOTTING MACHINE.

This is an extra heavy machine designed especially for forge work. The ram is provided with removable tool clamps on the front face and with a relief tool holder on the end. The crank is forged in one piece with the driving shaft. The ram and crank are both corrugated under the connecting rod washers to avoid slipping. The driving shaft has the Whitworth quick return motion with a large cone and driving gear. The work table is 26 ins. in diameter, has 18-in. longitudinal and 18-in. cross motion, and has a water channel all around.

The feeds are driven by a quick and easy cam movement on the large gear, and always take place at the top of the stroke during a very small movement of the ram. The ram guide is fixed in position 15 ins. above the table. The machine will take work up to 48 ins. in diameter. The motor application is especially compact. The motor is of 7½ h.p. capacity and has a speed variation of 3 to 1. With this variation no changes by gearing are necessary. The machine is made at the Niles works of the Niles-Bement-Pond Company.

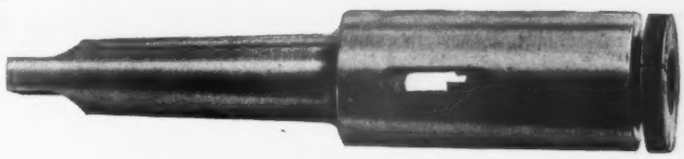



NILES 12-INCH EXTRA HEAVY SLOTTING MACHINE.

## SAGER AUTOMATIC GRIP DRILL SOCKET.

The Sager automatic grip drill socket was designed to prevent the breakage of the tangs of drills or other taper-shanked tools. It has a powerful grip which tightens automatically on the taper shank and drives the tool with no danger of breaking or twisting off the tang. It may also be equipped with a special or auxiliary sleeve to use drills with broken tangs. Reports from shops using this drill socket indicate a large saving in drills due to its use.

Its construction is simple and it requires no set screws, spanner wrenches, locking sleeves or retaining collars. No machine work is required on the shank of the drill in order to use this socket. To place a drill in the socket it is only necessary to slack off the sleeve three or four turns and insert the drill until it fits loosely against the top of the sleeve. The tang should project far enough above the sleeve to drift it out without touching the sleeve. The sleeve is tightened by hand sufficiently to hold the drill, and it tightens automatically when the drill starts to cut. To release the tool it is only necessary to drift it out in the same manner as with a common drill socket.



SAGER AUTOMATIC GRIP DRILL SOCKET.

AUXILIARY SLEEVE FOR SAGER DRILL SOCKET.

The grip being positive the drill will not fall through a hole when drilling through boilers or bridges. Special sockets are made for various pneumatic motors and also for spindles of wood-boring machines where set screws are generally used. Several of the large railroad shops are using these drill sockets, which are made by the Sager Drill Socket Company, Albany, N. Y.

MEETING OF THE A. S. M. E.—The Spring meeting of the American Society of Mechanical Engineers will be held at Chattanooga, Tenn., from May 1 to 4. The headquarters will be at the Read House, and the sessions will be held in the assembly hall of that hotel.

## COMPRESSED AIR SAND BLAST MACHINE.

The cleaning of metallic sufaces by means of the sand blast is coming to be recognized as the most satisfactory and cheapest method. Its field of usefulness is being extended

CLEANING CASTING WITH SAND BLAST MACHINE.

gradually until it is now covering the cleaning of both forgings and castings, as well as sheet and structural metal.

The uses that sand blasting has been put to in railroad shops have usually employed a crude and more or less inefficient apparatus of local make. However, as a broader field is developed, an apparatus of this nature is unsatisfactory and a more efficient and a machine less costly to operate is demanded.

The illustration herewith shows the sand blast apparatus furnished by the Tilghman-Brooksbank Sand Blast Company of 1126 South Eleventh Street, Philadelphia, Pa., who are probably the oldest firm in this field, having been established over twenty-five years. The sand blast machine shown uses compressed air at a pressure of from 10 to 20 lbs. per sq. in. to propel the sand and has a long flexible hose, permitting a wide radius of action. The machine itself consists of a steel drum, in the upper part of which is the sand reservoir and in the lower the mixing chamber. Suitable valves are furnished for gauging the supply of air and the proper mixture of sand, and a gauge on the air supply line indicates the pressure being used. A covered hand-hole in the side is so situated that all valves and parts subject to wear are easily accessible. All of the parts of the machine which are subjected to wear are made extra heavy, long experience having shown the weak points and how to correct them. The machines are made in four different sizes, using volumes of free air varying from 35 to 280 cu. ft. at 10 lbs. air pressure.

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Cost of Operating a Railway.—The following figures are taken from the annual report of an American railway operating 739 locomotives over 1,500 miles of track, the total engine mileage of all kinds being nearly 26,000,000: Repairs to locomotives, $1,280,000; repairs to freight cars, $1,238,000; wages to enginemen, $1,826,000; fuel for locomotives, $2,684,000; repairs and renewals to shop machinery, $181,000, and water supply for locomotives, $176,000.

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## AMERICAN LOCK NUT.

The demand for a successful and positive nut lock for use in the different departments on railroads has been very insistent. The difficulty and cost of discovering and tightening loose nuts on important bolts in locomotive and car work alone is recognized by all motive power men, and in addition to this the track department has similar troubles.

There are on the market a large number of devices or special arrangements for preventing nuts from turning on the bolt after they are once in place and locked which seem to cover every plausible scheme for accomplishing this desirable result. Some of these have proved practical successes and others have not.

In the former class may be included a very simple device, which is shown in the illustrations herewith. This is made by the American Lock Nut Company, 134 Congress Street, Boston, Mass., and consists of a small key of tempered steel, which is fitted into a radial slot cut in the thickest part of the top of the nut. The slot and key are of such shape that the key can be rocked; swinging on a slight projection at the bottom, and either have its edge forced into the thread of the bolt when in the locked position or can entirely clear the threads when in the unlocked position. The top of the slot in the nut is so compressed on each side against the beveled edges on the top of the key that the latter is prevented from coming upward and out of the slot, but its free movement is not obstructed. With this device, after the nut is tightened in place, a small punch is placed on the inner end of the key as shown by the arrow "to lock" and a blow forces the cutting edge downward into the threads of the bolt in a manner which makes it impossible for the lock to have any tendency toward working loose. However, if it is desired to remove the nut a similar blow on the outer edge of the key easily and quickly rocks it backward and allows the nut to be removed with a wrench without damage to itself or to the threads of the bolt. The nut used with these locks is the usual commercial nut unless otherwise specified and does not differ from the standard nuts in use in shape or size. The life of the lock is fully equal to that of the nut which can be used over again repeatedly.

## PERSONALS.

Mr. C. L. Meister has been appointed mechanical engineer of the Atlantic Coast Line Railroad.

Mr. C. E. Turner has been appointed superintendent of motive power of the Coal and Coke Railway.

Mr. George W. Smith has been appointed division master mechanic of the Wabash Railroad at Fort Wayne, Ind.

Mr. William J. Coakley has been appointed traveling engineer of the entire Cincinnati, Hamilton & Dayton system.

Mr. G. W. Seidel has been appointed superintendent of the East Moline shops of the Chicago, Rock Island & Pacific Railway.

Mr. E. J. Davis has been appointed master mechanic of the Washington, Idaho & Montana Railroad, with headquarters at Palouse, Wash.

Mr. George W. Stillwagon, general car foreman of the Pittsburg, Shawmut & Northern Railroad, has been appointed master car builder.

Mr. S. G. Wise has been appointed assistant road foreman of engines of the Middle division Pennsylvania Railroad, with headquarters at Hollidaysburg, Pa.

Mr. Oscar Dunton, Providence, Ky., is master mechanic of the Kentucky Valley Railroad, which has been completed and was put into operation on March 14th.

Mr. Henry M. Etchison has been appointed librarian of the Baltimore & Ohio Railroad at the Mt. Royal Station, Baltimore, Md., vice A. M. Irving, deceased.

Mr. C. D. Kunerth has been appointed general foreman of the Chicago, Rock Island & Pacific Railway at Herington, Kans., to succeed Mr. Wm. Evans, resigned.

Mr. J. C. Brackenridge has been appointed consulting engineer, in connection with electrification on the New York Central & Hudson River Railroad.

Mr. A. H. Hodges has been appointed general foreman of the Baltimore & Ohio Railroad at Brunswick, Md., to succeed Mr. Z. T. Bradtner, transferred to other duties.

Mr. R. C. Burns, assistant car inspector for the Pennsylvania Railroad at Altoona, has been appointed general car inspector, to succeed Mr. J. K. Roush, deceased.

Mr. J. C. Homer has been appointed master mechanic of the Cincinnati, Hamilton & Dayton Railroad, at Indianapolis, with jurisdiction over the I., D. & W. division.

Mr. J. P. Calligan, mechanical engineer of the Texas & Pacific Railroad at Marshall, Texas, died on March 20th from the accidental discharge of a gun while hunting.

Mr. H. L. Leach has been appointed assistant superintendent of motive power and equipment of the Bangor & Aroostook Railway, with office at Houlton, Me.

Mr. P. F. Risteen, mechanical superintendent of the eastern division of the Atchison, Topeka & Santa Fe Railway, died at his home in Topeka, Kansas, on March 26, 1906.

Mr. Frank P. Roesch, formerly master mechanic of the Chicago & Alton Railway, has been appointed master mechanic of the Southern Railway at Birmingham, Ala.

Mr. David H. Wilson, Jr. has been appointed electrical engineer for the Erie Railroad, in charge of the power plants and other electrical equipment along the entire system.

Mr. M. D. Stewart has resigned as superintendent of motive power of the Chicago, Peoria & St. Louis Railway, to become connected with the Fitz-Hugh, Luther Company, Chicago.

Mr. W. J. Collins, general foreman of shops of the Chicago, Burlington & Quincy Railway, with headquarters at St. Louis, has resigned to accept a similar place with the Wabash Railroad.

Mr. E. F. Needham, heretofore division master mechanic of the Wabash Railroad at Fort Wayne, Ind., has been appointed division master mechanic at Springfield, Ill., succeeding Mr. C. H. Doebler, resigned.

Mr. E. J. Smith, heretofore master mechanic of the Atlantic Coast Line at High Springs, Fla., has been appointed assistant superintendent of motive power of the third division of that company, with office at Jacksonville, Fla.

Mr. A. L. Rossetter, heretofore master mechanic of the Chicago, Peoria & St. Louis Railway, has been appointed superintendent of motive power, and Mr. W. T. Cousley, master car builder, with headquarters at Springfield, Ill.

Mr. R. G. Long, general foreman of the Missouri Pacific at Fort Scott, Kans., has been appointed division master mechanic of the St. Louis, Iron Mountain & Southern Railroad at McGehee, Ark., in place of Mr. A. McCormick, resigned.

Mr. J. H. Wynne has resigned as mechanical engineer of the Illinois Central R. R. to accept the positon of western manager of the Atlantic Equipment Company, with headquarters at Chicago. He will also represent the American Locomotive Company.

Mr. W. F. Buck has been appointed mechanical superintendent of the Eastern Grand Division of the Atchison, Topeka & Santa Fe at Topeka, Kansas, to succeed Mr. F. N Risteen, deceased. Mr. Buck was formerly master mechanic of the Santa Fe Coast Line at Needles, Cal.

Mr. J. E. Keegan, heretofore master mechanic of the Grand Rapids & Indiana R. R., has been appointed superintendent of motive power, with headquarters at Grand Rapids, Mich. Mr. J. F. Hayes has been appointed master mechanic, with office at Grand Rapids, to succeed Mr. Keegan.

Mr. G. M. Brill, the well-known head of the J. G. Brill Company, died of apoplexy at his home in Merion, Pa., on March 31st. Mr. Brill was 62 years of age and had followed the business of constructing street cars from early manhood, building up one of the largest and best companies in the country.

Mr. C. K. Shelby, assistant engineer of motive power of the Pennsylvania Railroad and the Northern Central at Williamsport, Pa., has been appointed master mechanic of the latter road at Elmira, N. Y., succeeding Mr. John M. Henry, who has been appointed master mechanic of the Pennsylvania at Sunbury, Pa. Mr. J. L. Cunningham has been appointed to succeed Mr. Shelby as assistant engineer of motive power at Williamsport.

Following the promotion of Mr. H. M. Carson, superintendent of motive power of the Pennsylvania Railroad at Buffalo, N. Y., to be assistant to the general manager, Mr. R. K. Reading has succeeded Mr. Carson as superintendent of motive power at Buffalo, N. Y., and Mr. D. M. Perine has been appointed superintendent of motive power on the Philadelphia & Erie and Northern Central; Mr. J. T. Wallis, master mechanic at West Philadelphia, and Mr. J. C. Mingle, master mechanic, at Baltimore, Md.

Mr. Robert Miller died at his home in Detroit on March 13th. Mr. Miller entered the service of the Chicago, Burlington & Quincy Railroad in 1859 as a journeyman carpenter, and when the war broke out he enlisted in Company E, Eighty-ninth Illinois, which was known as one of the "railroad" regiments. He was successively promoted from the ranks to first lieutenant and was mustered out in 1865. He then went back to the C. B. & Q. R. R., remaining with the road until 1876, when he became master mechanic of the Michigan Central. Following this he became assistant general superintendent, general superintendent and was finally appointed superintendent of motive power and equipment, which position he held until 1900, when he retired from active business duties.

## CATALOGS.

IN WRITING FOR THESE, PLEASE MENTION THIS PAPER.

ROCK CRUSHING MACHINERY.—The Power & Mining Machinery Company, Cudahy, Wis., is issuing catalog No. 4, which describes and illustrates the McCully gyratory rock crusher, as well as hoists, dump cars, conveyor belts and other rock crushing appliances.

G. E. FAN MOTORS.—The General Electric Company, Schenectady, N. Y., is issuing a catalog which thoroughly describes and illustrates the different types of electric fans and the motors which drive them, the latter being shown in detail. These include many new arrangements for electrc fans.

OUT-DOOR CRANES.—The Niles-Bement Pond Company, 111 Broadway, New York, is issuing a catalog which shows by means of illustrations of recent applications the many different types of cranes for out-door service which are manufactured by it. A very wide range of application is shown in the illustrations

COLD SAW CUTTING-OFF MACHINERY.—The Newton Machine Tool Works, Philadelphia, Pa., is issuing a catalog which illustrates by means of views and line drawings a large variety of cold saw cutting-off machines, which are arranged for work on many different shapes. Vertical and horizontal machines are shown.

SCREW WRENCHES.—The Coes Wrench Company, Worcester, Mass., is issuing an attractive catalog which illustrates and describes the different types of screw wrenches manufactured by this company, which started the manufacture of wrenches in 1843, and has given the subject probably closer and longer study than any other single firm

CORUNDUM WHEELS.—The Star Corundum Wheel Company, Ltd., of Detroit, Mich., is issuing catalog No. 8, of standard size, containing over 100 pages in which are illustrated and described an exceedingly wide range of shapes and sizes of grinding wheels made of both emery and corundum, as well as grinding machines, grinding appliances, oil stones, etc.

RATCHET JACKS FOR CARS AND TRACKS.—The Buda Foundry & Mfg. Company, Railway Exchange, Chicago, is issuing a catalog which illustrates and briefly describes the many different kinds of ball-bearing rachet jacks for use in different kinds of service, manufactured by it. In connection with each jack a table of numbered parts giving the prices for each piece is shown.

TESTS OF DIXON'S FLAKE GRAPHITE.—In the April issue of "Graphite" is given an account of a test, made by Professor Goss of Purdue University, of Dixon's flake graphite as a lubricant. The tests were made between a lubricant of clear kerosene and mixtures of graphite and kerosene. The addition of the graphite permitted the load to be increased 120 per cent., and gave a reduction in the co-efficient of friction of 45.9.

BRAKE HANGER.—The J. J. Brill Company, Philadelphia, is issuing a catalog which thoroughly illustrates and carefully describes the new Brill noiseless brake hanger, which is arranged to use a ball and socket joint at the brake head. In this the cap socket is always held firmly on the ball by a wedge which is advanced by a pair of springs as the socket becomes worn. This equipment is all included in the brake head and forms a hanger which is practically noiseless.

SPRING PAINTING.—The Joseph Dixon Crucible Company, Jersey City, N. J., is issuing a leaflet which sets forth the advantages of the Dixon-silica graphite paint for use on both wood and metal work. This paint has been in successful use for over 40 years and has proven itself to be an exceptionally good protection from either weather or gases.

WESTINGHOUSE FAN MOTORS.—The Westinghouse Electric & Manufacturing Company, Pittsburg, Pa., is issuing a catalog which shows by means of illustrations of installations, as well as illustrations of the different types of fans themselves, all of which are briefly described, a large assortment of desk, bracket, ceiling and floor fans using either direct or alternating current. In the same catalog is also included descriptions of small motors for either direct or alternating current ranging in power from 1/20 to ⅛ h.-p. Price lists are given.

HORIZONTAL ENGINES.—The B. F. Sturtevant Company, Hyde Park, Mass., has issued bulletin No. 131 of its engineering service, which describes the Sturtevant horizontal centre crank engines. These engines are designed particularly for the driving of direct connected generators, and can also be used successfully as independent engines. The illustrations show the main parts and important details, as well as the completed engine. A table showing net horse-powers with different sizes of these engines operated under different steam pressures is given.

## NOTES.

STRUCTURAL STEEL WORK.—The Pennsylvania Railroad Company has awarded a large tonnage of structural steel work for use on the improvements and new station at East Pittsburg, Pa., to Wm. B. Scaife & Sons Company, of Pittsburg, Pa.

WESTINGHOUSE ELECTRIC & MANUFACTURING COMPANY.—The erecting department of this company, for Manhattan Borough which has been located on the 19th floor of the Trinity Building, has been removed to the Fuller Building, Twenty-third Street and Broadway, New York City. This change was made necessary because of the need of more space.

FLANNERY BOLT COMPANY.—Notice has been sent out that Mr. W. M. Wilson has been appointed western representative with office at Chicago, and Mr. Tom R. Davis has been appointed mechanical expert and traveling representative of the Flannery Bolt Company of Pittsburg, which manufactures the Tate flexible staybolt.

INGERSOLL RAND COMPANY.—Mr. C. Frank Schwep has been appointed general purchasing agent of this company at 11 Broadway, New York. Mr. Schwep has been at the head of the purchasing department of the Ingersoll-Sargent Drill Company for the past thirteen years, and was located at the shops at Easton, Pa., and Phillipsburg, N. J.

WESTINGHOUSE MACHINE COMPANY.—This company received orders during the month of March and February for 35 steam turbines, aggregating approximately 50,000 brake h.-p. capacity. The largest of these was of 7,500 k.w. or 11,000 brake h.-p. capacity, which will be installed by the Transit Development Company of Brooklyn. The other machines were for use in different parts of the country.

COMPRESSED AIR.—It is announced that beginning with its issue of May "Compressed Air" will appear in enlarged form and under new management Hereafter it will be published by the Kobbe Company, 90-92 West Broadway, New York. Founded ten years ago, it is the only publication devoted exclusively to the field of compressed air in all its applications. W. L. Saunders will remain as editor-in-chief, W. R. Hulbert will be managing editor and P. F. Kobbe, Jr., will be business manager.

MANUFACTURERS' ADVERTISING BUREAU.—This bureau, which was established in 1877, has for some time found its Liberty Street offices too small for its increasing business and it is now removed to 237 Broadway, New York City. The bureau intends to broaden the scope of its work, and, while particular attention will be given to advertising in the trade and technical journals as heretofore, it will also be equipped to handle advertising in newspapers, magazines and other periodicals.